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LABOR RESOURCE AUDIT AND ANALYSIS:
A TOOL FOR MANAGEMENT PLANNING AND CONTROL

by

Larry J. Macias

June 1989

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Labor Resource Audit and Analysis:
A Tool for Management Planning and Control

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Submitted in partial fulfillment of the
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ABSTRACT

This study was conducted in an effort to develop improved techniques for labor resource analysis and reporting to enhance workload management and planning. A labor resource audit is described that is sufficiently flexible and adaptable to all Navy public works activities. This thesis presents a step-by-step method to analyze, design and implement a prototype labor auditing system for determining and budgeting for proper level, mix, and balance of personnel to support maintenance and repair operations. Specifically, this thesis focused on workload growth, backlog completion time, personnel and funding shortfalls in the area of real property maintenance and repair at the Naval Postgraduate School. Information developed provided insight into: effectively identifying resources to decrease backlog; managing incoming work requests more effectively; and providing financial accountability and credibility at middle management levels.

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I. INTRODUCTION

A. BACKGROUND

Proper identification and control of available resources for scheduling, timing, material and labor for facilities management in the Navy is a necessity, but controlling the allocation of resources becomes increasingly difficult as projects become back-logged, larger, and more complex. Yearly inflation, cost of labor, equipment, and material combined with government funding policy (near level to incremental budgeting) has seriously impacted the Navy's facilities management program. This situation results in constraints that have left Public Works Department's (PWDs) with an ever-expanding list of maintenance deficiencies. Typically funds available this fiscal year do not provide the same coverage as in previous years; therefore, management must constantly find more effective means to accomplish dollar stretching in times of decreasing budgets and increasing requirements. In addition, a funding policy which places increased fiscal responsibilities at lower levels of management brings increased flexibility to middle managers, but also new requirements for more sophisticated applications of tracking such managerial flexibility.

Today more than ever a Public Works Officer (PWO) needs to ask hard questions and make unpopular decisions

concerning utilization of maintenance, repair, and shop resources. They must be ready to answer such questions as: Where are maintenance and repair monies being spent? Can expenditures be reduced? Are expenditures justified in meeting command objectives? Can management and/or procedures be improved? Are there more efficient ways of doing business, using less resources and providing cost effective quality service? Do current figures and performance compare to estimates? Is Public Works (PW) dynamic in reassessing and reallocating resources to meet increasing or changing mission requirements?

To approach rational decisions on these issues, managers must receive accurate and relevant information as a basis for their analysis. There is a growing awareness throughout PW for planning and control techniques, closely linking available labor to financial and physical progress, and a need for quick reporting of variances from planned progress in both physical and financial terms.

B. FUNDING POLICY

Current government funding policy which places increasing fiscal responsibilities at lower levels of management has brought not only increased flexibility to middle managers, but also a requirement for more sophisticated methods of decision support. To understand the implications of this flexibility, it is helpful to

review briefly the means by which local activities are funded.

Congress through public laws (Appropriation Acts) assigns funds to agencies for specific, previously authorized programs. After funds or appropriations are released to agencies, the Office of Management and Budget (OMB) apportions funds to the Department of Defense (DoD) and limits obligations which may be incurred during a fiscal year. Funds are then allocated from DoD to the Comptroller of the Navy, from the Comptroller of the Navy to Chief of Naval Operations (CNO) and from CNO to major claimants for distribution to responsibility centers such as the Naval Postgraduate School. Responsibility centers are authorized to incur obligations within a specified amount (Figure 1-1). [Ref. 1:pp. I-4--I-11] Operations and Maintenance, Navy (O&M,N) funds are subdivided by responsibility centers and given as operating targets (OPTARS) to cost centers. A cost center is a subdivision of a responsibility center, the responsibility for which is generally assigned to one supervisor. A local management code (LMC) is a subdivision of a cost center broken down by purpose or organization. At the Naval Postgraduate School, a significant source of funds flows indirectly to the command through reimbursable jobs. A reimbursable is a lateral flow of resources from other government activities to finance services provided by a host in compliance with a host-tenant agreement between

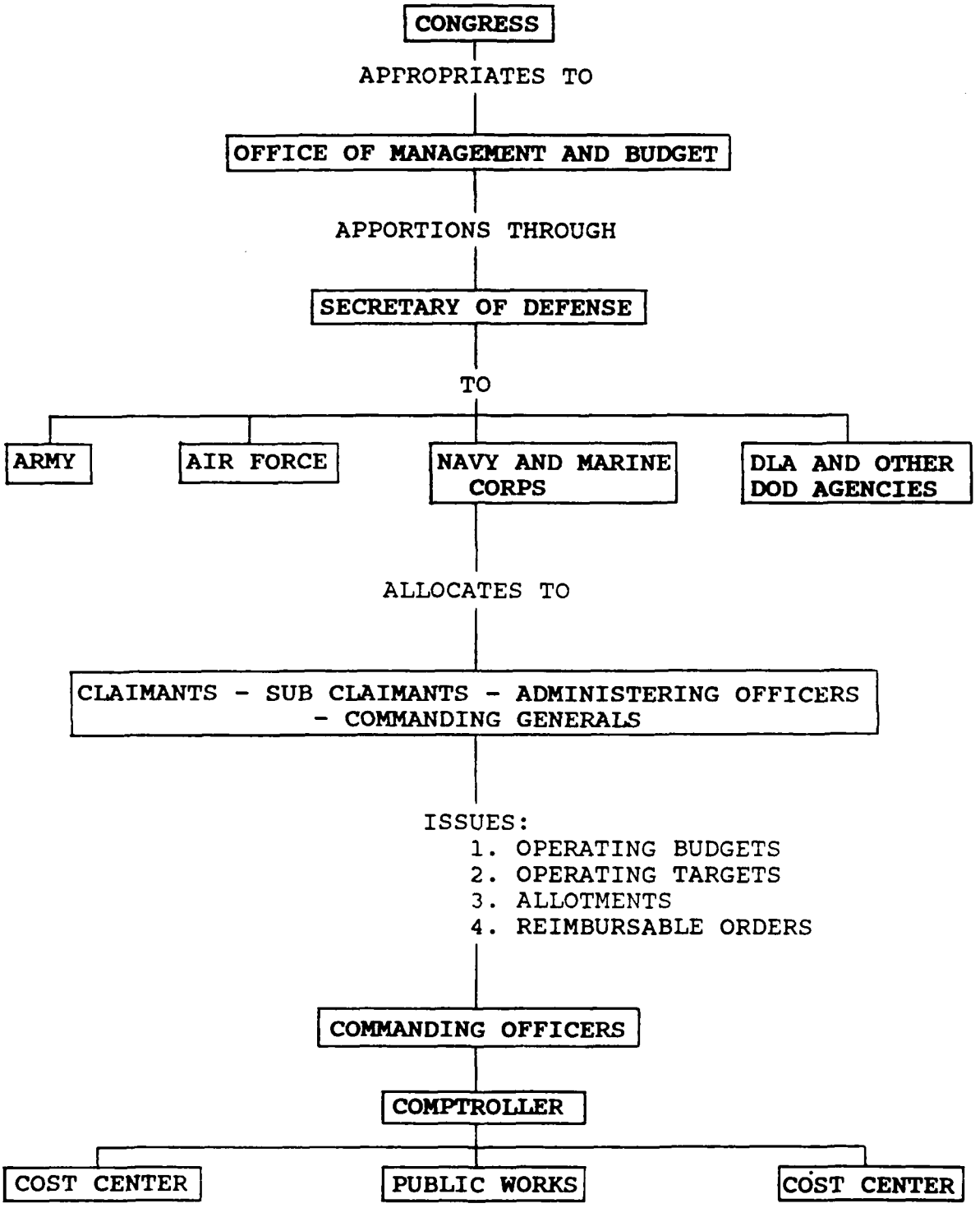


Figure 1-1 Flow of Funds

activities. The host identifies the source of funds used to accomplish reimbursable work for the tenant with a four character segment number.

C. PROBLEM STATEMENT

Public Works Departments responsible for making programming and budgetary decisions to support a Navy shore establishment often do not have analytical tools necessary to justify labor resources required to meet specific operating objectives. Furthermore, PW often cannot adequately defend against arbitrary across-the-board funding cuts, which are often assessed with apparently little or no understanding of deleterious mission-effects. Budgets prepared and imposed, frequently by non-technical management, often require PW to operate within financial limits that may be virtually impossible to achieve with the type of labor, skills, and resources available. This situation may be further aggravated by age, poor condition of plants, facilities, and buildings that have deteriorated due to lack of attention, inadequate funding levels, and/or low levels of maintenance importance. Consequently, there is a clear requirement for a computer modeling methodology for demonstrating the effects of labor availability on PWD mission performance.

The concept of Backlog of Maintenance and Repair (BMAR), used as a shore base readiness indicator, is inadequate. It addresses only deficiencies, which are not necessarily

mission-critical, and does not address labor availability to correct deficiencies. Moreover, BMAR levels have not been reduced despite increased infusion of maintenance funding.

Even if the BMAR indicator could be redefined along mission lines of resource availability, there are serious problems with alignment of existing budget categories within PWD missions. Budget Activity Groups and Sub-Activity Groups, such as Other Engineering Support, and Other Base Services, represent funds that blanket many shore base missions, making it difficult or impossible to isolate resources that affect specific mission areas. Since there has been no means for relating funding to these mission areas, budget cuts are generally assessed against major Maintenance and Repair of Real Property (MRRP) projects which further increases BMAR, thereby leading to unending degradation and increased maintenance backlogs.

One recent development to remedy this situation is the BASEREP reporting system, which was composed of three major efforts: (1) Development of a mission-oriented system (BASEREP) for measuring shore base readiness, much like the fleet UNITREP system used for ships and aircraft squadrons; (2) alignment of shore base operating support financial categories with these UNITREP style mission arrays; and (3) usage of econometric modeling techniques to develop equations that link financial resources with respective measures of readiness. [Ref. 2]

The BASEREP readiness reporting system has already become a reality. It has already been used for several purposes: to reveal the deleterious readiness effects of various proposed MRRP cuts; to provide out-year estimates of facilities condition readiness as a function of proposed out-year MRRP resource profiles; and to obtain estimates of MRRP funding required to attain various facilities-condition readiness goals. This is definite progress, representing a fresh mission-oriented approach to the measurement of base readiness and a complete departure from the unsatisfactory and unpopular BMAR concept.

Information performs a vital role in the maintenance manager's environment. The PWD information system must provide means to identify available labor resources to effectively manage maintenance and repair functions. Failure of management to create, control, and communicate information regarding available labor is costly, results in fewer services, and develops a negative work atmosphere. The effect of negative atmosphere varies, but, generally, individuals are not inspired working under the "Hey, Joe" system of assignment and control.

Demand for higher productivity and increased outputs are imposing greater demands on facility maintenance. Management must be called upon, be responsive, and held accountable for improved standards, methods, and efficiency necessary to reduce maintenance costs.

This thesis is about how to identify and determine the necessary labor resources and budget base required to support operations of a Public Works Department. The Public Works Department at the Naval Postgraduate School (NPS) is used as a case study.

1. Naval Postgraduate School (NPS)

The mission of the U.S. Naval Postgraduate School is stated as follows:

> To conduct and direct the advanced education of commissioned officers, and to provide such other technical and professional instruction as may be prescribed to meet the needs of the Naval Service; and in support of the foregoing, to foster and encourage a program of research in order to sustain academic excellence. [Ref. 3:p. 6]

2. The Public Works Officer

In support of the school's mission, the PWO is responsible to the Assistant Director of Military Operations (Figure 1-2) for providing NPS as well as various tenant commands with maintenance, utilities and transportation support.

Partially because of provisions of the anti-deficiency act prohibiting over-expenditure of funds, PW is staffed (Figure 1-3) with an Administrative Officer (AO) who is tasked with administration coordination and direction of PW budget, finance and organizational methods and procedures. The position description of the Administrative Officer identifies the AO as being responsible for budget formulation, presentation, and for advising on status and

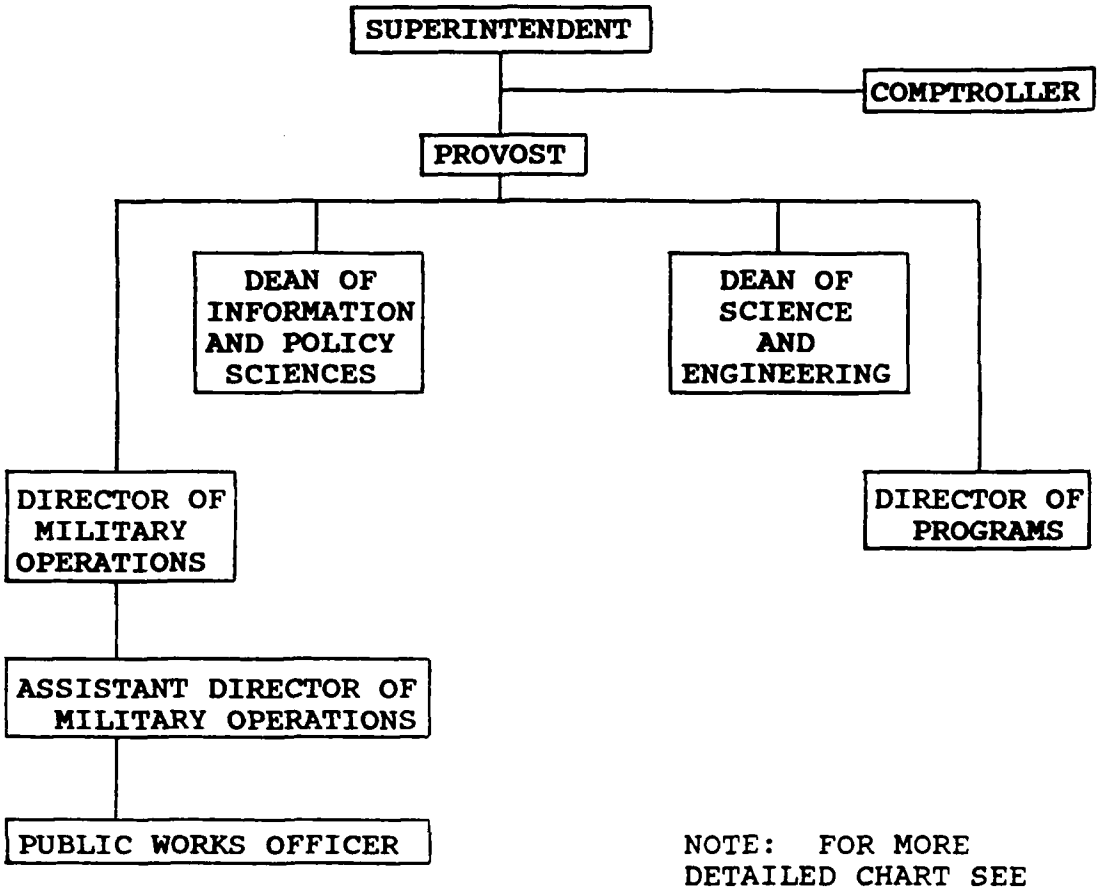


Figure 1-2 Naval Postgraduate School Organization

availability of funds as well as capabilities of the department to meet objectives with available resources.

Resources available for support provided to NPS are constrained by annual operating targets. Resources available for reimbursable services provided to tenant commands are constrained by the amount of money provided by the tenant command to PW at the beginning of the fiscal year.

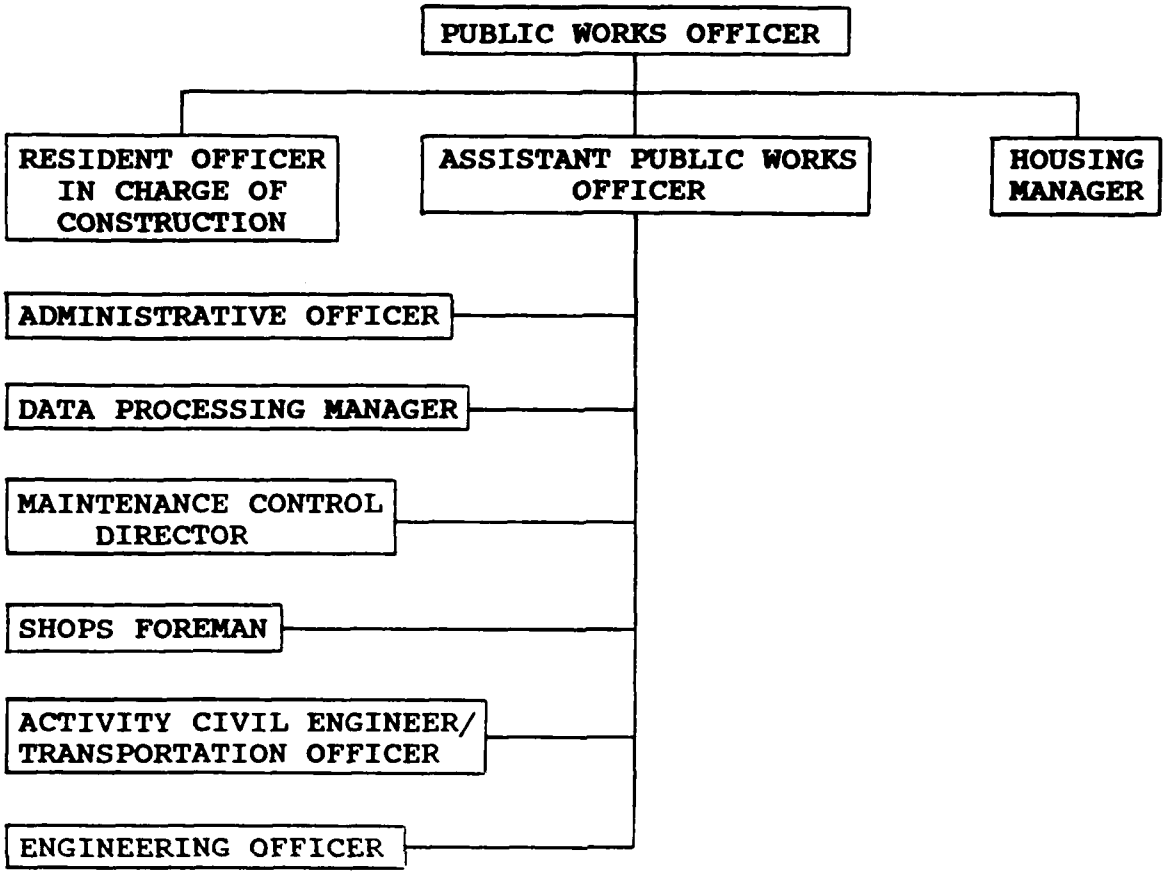


Figure 1-3 Public Works Department Organization

It is of great importance for the PWO to know the dollar value of resources available and consumed to date by each LMC and the value of resources charged to each segment number for reimbursable jobs in the fiscal year to ensure that appropriate resources are maintained and managed efficiently, and that reasonable policy decisions are made concerning the priority assigned to reimbursable versus non-reimbursable jobs.

The NPS Comptroller is tasked with monitoring the use of labor funds. The Comptroller maintains official labor statistics, determines policies such as that governing the assignment of appropriate acceleration rates to be applied to various labor charges and must account for any differences between hours reported on labor distribution cards (i.e., those used to ensure that particular appropriations are spent in areas for which they were appropriated) and hours reported on time cards (i.e., those used in processing the payroll). The Comptroller also must have access to valid information to effectively monitor the execution of the labor budget. Although in theory the Comptroller Office maintains the official labor figures, they do so on WANG office equipment which currently lacks the capability to transfer the data to Financial Information Processing Center (FIPC), Washington, D.C. Therefore, actual time cards are mailed to Washington where they are keypunched for entry via card reader into a system known as Integrated Disbursing and Accounting (IDA). The WANG system holds Memorandum Labor Records which while not official are used to identify labor card data erroneously entered into IDA and to reconcile differences between time card and labor card entries.

To eliminate duplicated effort, accelerate financial data transfer, and provide timely feed-back the Comptroller Department needs to fully utilize existing Local Area

Department needs to fully utilize existing Local Area Network (LAN) and telecommunications capabilities. However, at this time the Comptroller Department lacks the technical expertise and trained personal to make this a reality.

D. EXISTING CAPABILITIES

1. Base Engineering Support, Technical (BEST)

The Base Engineering Support, Technical (BEST) system was installed to provide a PWD with information support in areas of facilities maintenance, utilities, transportation, and family housing. The maintenance function involved modules which assist the PWO in evaluating effectiveness of various cost centers. Specifically, modules indicate how a cost center or even specific employees are performing with respect to Engineering Performance Standards (EPS), and evaluates the accuracy of cost estimates.

To provide these functions, BEST requires entry of actual project data in a format different from that used on labor time cards; therefore, information is entered into BEST separately at the shops level.

BEST was not initially designed to support PW in budget execution. The module which would make this possible was not included in the initial system development because a similar function was to be included in a financial information system expected to be operational in the mid 1990's. However, a recent development in Public Works

Management Automation (PWMA) policy from Naval Facilities Engineering Command (NAVFACENGCOM) [Ref. 4] states:

> NAVFACENGCOM will support and maintain existing systems (i.e., BEST minicomputer subsystems) but will not devote a great deal of effort to enhance or expand those applications. Future efforts will be focused on networked microcomputer applications. However, system configuration and installation are activity responsibilities.

Therefore, PWDs must independently fulfill this "once-promised" requirement using existing staff which in all probability lacks the technical capability and expertise to resolve this magnitude of "independent" system development. As a result of lacking support and proper development efforts to interface a financial information system to BEST, many costly manhours of effort are expended from an already depleted PWD budget. The author is convinced that this type of independent shoe-string development is unproductive, not in compliance with current Navy policies and is very expensive. In addition systems developed lack management control, user documentation and are not transferrable between activities.

Currently, actual hours expended on a given project or job category are reported in a separate system without significant error checking. No convenient mechanism exists to allow legitimate comparison between total effort as per BEST and total effort as per labor cards. The level of confidence in actual hours expended on a project as per BEST must be significantly improved. Without a fielded standardized financial information interface to BEST, PWDs

are unable to reconcile accounts in a timely, efficient and acceptable manner.

2. Turbo Pascal System

In June of 1986, a PW employee at NPS developed a labor distribution and accounting system in Turbo Pascal for the IBM-PC. The design and data structures for the system showed insight into the complexity of the problem.

Although the system represented a significant improvement over a completely manual system, it was deficient in several key areas. Text files were manipulated by Wordstar, a word processing program. This necessitated training of entry clerks to use Wordstar and input files had to be formatted in a strict fashion. Stray characters caused frequent program malfunctions. Files eventually grew to be large, and it was difficult to find and change entries; therefore, duplication of entries and omissions were common and usually progressed through the system undetected. Because of the way databases were joined, the program took several hours to generate the equivalent of a Fund Code Report. Documentation of the program was sparse, and procedures were cumbersome, making the program difficult to maintain.

3. AIMS System

The Comptroller Department maintains their memorandum accounting records on a WANG computer using AIMS software package. AIMS is a relatively user-friendly

off-the-shelf database program. Transactions are entered into the AIMS system when four Comptroller Department entry clerks copy data from labor cards filled out by NPS employees assigned to departments other than PW. The time cards are then sent to Washington, D.C., for keypunching and entry into the IDA system.

Each local record is deleted from the WANG system when the record appears on the IDA Transaction Listing. The reconciliation process is very time and labor intensive and would be unnecessary if transaction data entered at the local level were transferred to the IDA system in machine readable form. The current capabilities of WANG preclude this alternative.

Although the AIMS system supports the Comptroller to some degree, it provides no support for Public Works.

4. LABORMON

The LABORMON system was developed by thesis students Donald H. Hildebrand, Jr. and Andrew Marafino, Jr. in early 1987. LABORMON is a system based on Lotus 1-2-3 spreadsheet macros and templates which was designed to help lower-level managers manage their payroll. It suffered from the fact that 1-2-3 does not support the relational model. Hence, the software could not support very sophisticated relations and could not easily be altered to meet long-term Comptroller requirements. The program employed very little error checking, was never implemented and was abandoned by

the Comptroller Department because of an absence of top-management interest and maintenance programming support.

5. DATABASE FOR MONITORING LABOR COSTS

The DATABASE system was developed by thesis student David P. Dinwiddie, and became operational in September 1987. Labor cost monitoring was developed for microcomputer applications utilizing dBASE III (PLUS) program language. It corrected many discrepancies, established an efficient and effective labor cost tracking system, was user friendly, and provided sufficient flexibility for adjustment as additional user requirements evolved. However, DATABASE tested projects against total labor cost, it was unable to test for or distinguish between closed and/or completed job orders; therefore, it did not identify employees erroneously charging labor against such accounts. Furthermore, it did not provide break-out charges by individual work centers which prevented management to assess work load scheduling and its impact on labor/financial resources and production.

DATABASE was developed for under $3,500 and due to the reduction of data redundancy it was estimated that savings of $7,500 annually were achieved. DATABASE provided excellent results, support, and timely information.

In January 1989, the NPS's Authorized Accounting Activity (AAA) changed from Oakland, to Washington, DC., and due to differences in accounting procedures between the two AAA's, DATABASE now requires a 100% re-write.

6. DATABASE Re-Write

The DATABASE program is currently in the process of being re-written by Mr. John T. Perry, the computer specialists at PWD, NPS. The re-write will accommodate the necessary changes to accounting procedures, expand existing database files, correct short-falls in the original program by allowing for cross checking tests within the database, and reduced efforts to maintain and update files. Current development takes into account on-line access through LAN within NPS (i.e., between Public Works and Comptroller Departments) and telecommunications between NPS and the AAA Washington.

The author of this thesis provided assistance in re-writing by expanding the database to identify and include: work backlog by trade and work center; labor budget requirements; mix of labor resources, and development of on-line capability to account for expenditures and manpower utilization for comparison to the BEST system.

E. PURPOSE

The purpose of this thesis is to analyze, design and implement a prototype labor auditing system for determining and budgeting for proper level, mix, and balance of personnel to support maintenance and repair operations at a PWD. Information developed will help provide a requirements document for a manpower identification, utilization, and scheduling prototype system to be incorporated into the

existing Base Engineering Support, Technical (BEST) system and fielded world wide to support labor and budget decisions. As secondary objectives, it is anticipated that labor auditing may provide insight into effectively utilizing resources to decrease backlog, manage incoming work requests more effectively, and provide financial accountability and creditability at middle management levels.

F. METHODOLOGY

Data for analysis was obtained from Base Engineering Support, Technical (BEST) system and current records at PWD, NPS, Monterey, California. Additional information was obtained from automated reports which provided background information on how effectively they were serving management for decisions on matters of budgets, priority of planning and scheduling, allocating labor, and control/monitoring work performance. The remainder of data was obtained through interviews with management, personnel, and on site observations of the work force.

II. LABOR RESOURCE IDENTIFICATION AUDIT

A Labor Resource Identification Audit (labor audit) is a starting point for implementation and control of labor resources for budget conservation. To understand this auditing process, we consider these questions:

- What is a labor audit?
- Who should conduct a labor audit?
- When and how often should it be conducted?
- How should it be done?

A. WHAT IS A LABOR AUDIT?

A labor audit is a critical examination of how personnel are utilized and what capabilities exist within a department. The process of examinating labor might be simple or involved, depending on objectives. Typical objectives are: identification of existing capabilities, or the lack of them, identification of critical mission activities, comparison of labor variance, identification and analysis of saving opportunities, and development of procedures for control and reporting.

There are many levels of labor audits. There are macro and micro audits and department surveys. A macro audit consists of recording and analyzing labor resources used by each department over a fixed period of time. A macro audit can be performed by a quick walk-through of a department and

by analysis of time cards, payroll, and labor variances. Due to time, budget, and other constraints, one may want to limit oneself to a macro audit for certain departments or cost centers.

A micro audit consists of recording complete labor resources available and how they are used for every cost center over a fixed period of time, and calculating labor balances and efficiencies. A department survey consists of identifying obvious labor wastage situations, recommending labor saving opportunities through supervision, education, improved maintenance and operating procedures, and analyzing labor conservation opportunities through system or procedure modifications.

The scope should be defined by the labor analyzing team in advance. Time taken to conduct a micro audit will depend on size and type of cost centers. Only cost centers that are labor intensive should be analyzed in great detail. The auditing process described here may be used to conduct audits of different types and at various levels of detail.

B. WHO SHOULD CONDUCT A LABOR AUDIT?

The labor audit can be conducted by an individual or a team of individuals having significant experience in management and operation of the particular department being audited. Actual composition of the team will depend on:

- Organization of the labor analysis program.
- The size and type of departments or cost centers.
- The objectives of the audit.

1. The Individual Auditor

There is nothing mystical about a labor audit. It is a study of a command, department, or cost center to determine where and how efficient labor resources are used. It is the nucleus of a successful budget saving program, the foundation on which a labor base is built; it is a tool, not a solution.

The most difficult part of a labor audit for most managers is getting started. Generally, it is difficult to determine:

- What to look for.
- How accurate to be.
- Where to begin.

As with most projects, individuals tend to see how complex the audit may be rather than how easy it is if taken one step at a time. In fact, managers can make each phase a learning process for subsequent steps. Limited knowledge of this process should not be allowed to stop anyone.

2. Team Approach

A survey team and an analysis team are needed to conduct a detailed audit. Survey teams are responsible for identifying opportunities and collecting data. Analysis teams are responsible for analyzing opportunities and

calculating benefits. Typically, a surveying team should be composed of a foreman, plant engineer, and a maintenance supervisor. This team should be experienced in the area(s) being surveyed and familiar with current operating and maintenance practices.

The analysis team may be composed of many different personnel. Depending on the scope, analysis teams may consist of one or two members with an engineering background, supported by persons with accounting, finance, and computer skills or, as needed.

C. WHEN AND HOW OFTEN SHOULD A LABOR AUDIT BE CONDUCTED?

The labor survey should be done during normal working hours and during weekends, night shifts, and holidays if applicable. Survey teams must find out how effective and efficient personnel are during every hour of the day, every day of the week. It is not unusual to find poor scheduling techniques, wasted man hours and lost production due to lack of materials, improper tooling, and poor supervision that has gone undetected and unreported for extended periods of time.

A macro audit of every department should be done as soon as the program is begun. From results of the macro audit, one can pick out candidates for detailed managerial or technical analysis. This should be done as fast as schedules permit. Budget savings and true labor available

for scheduling will begin only when corrective action is taken as a result of the audit.

Most military managers do not know, or pay attention to available labor resources; therefore, informed decisions and true capabilities of a command, department, and cost centers can not be made in the event of budget cuts. Due to the high costs of labor and benefits, and the need to do more work with less funding, the author recommends that a labor survey of each department be conducted at least once a year and prior to the budget call. A labor resource committee should prepare a detailed schedule for auditing each department and cost center and to notify all members of the audit team in advance. Analysis, on the other hand, is performed continuously.

Figure 2-1 illustrates the place of an audit in the development of a successful labor resource program. The audit precedes the planned actions; it does not follow them.

D. HOW SHOULD A LABOR AUDIT BE CONDUCTED?

To start a labor audit is to realize that it should be done in two stages. The auditing process consists of observing a department (macro audit) and analyzing results of observation (micro audit).

1. Two Phases of Labor Auditing

a. Macro

A broad overview that helps orient the auditor for the most effective approach to the project. This is

I. LABOR AUDIT

A. Where and how are labor resources used

B. Evaluate labor conservation potentials

C. Project labor needs and take necessary action

D. Communicate importance to the department

II. EDUCATION (Help People)

A. Upper management (understand labor utilization)

B. Middle management (findings and plans)

C. Labor force (in terms they can understand)

III. EFFICIENCY IMPROVEMENT

A. Evaluate present labor resource usage patterns

B. Screen for better ways

IV. RESEARCH, DEVELOPMENT AND IMPLEMENTATION

A. Process or product restructuring

VI. MONITORING AND REPORTING OF LABOR SAVINGS

Figure 2-1 Labor Resource Management Plan

like looking at the globe of the world to identify the various continents and countries or, in this case, the command, department, and work centers.

b. Micro

A more detailed analysis that focuses on specific areas identified in the macro audit. This is similar to looking for a particular address location on a road map; easy once we know which state and town to look in.

2. The Macro Audit

This is a broad look at how much labor is actually used by a specific department. Macro audits start with different types of labor resources available and convert them to a useful common base such as manhours (or labor hours). After they are accumulated to identify total usage, manhours are traced individually to each appropriate department or cost center. Generally, information needed for this portion of the audit, listed in descending order of importance, is:

- Several years of labor utilization history (in mandays, labor hours, mission requirements, and so on). This information is available from personnel rosters, time cards, labor variance data, or position descriptions, which the command's accounting and administrative departments can provide.

- Cost Center-by-Cost Center labor utilization. Occasionally this information is available, but it should not be used until its accuracy is confirmed. Unless the labor requirements are actual, data may have been allocated by a clerk for accounting purposes due to multiple cost center involvement.

- Operating or production record. Which record to obtain depends on whether the work is administrative, emergency service, service call, minor/specific, or standing job orders. The record should be developed in terms of hours of operation and labor loading requirements or units completed per period. This information is used to give the labor requirements typically used in producing a task or, labor base currently required to run the cost center.

- Cost Center-by Cost Center labor requirement list. This should identify labor requirements currently used in each area. Included should be labor consumption, approximate labor cost per hour, and whether labor requirements are mission essential or not.

Once the available information is gathered for each type of labor resource, it should be listed in a useful way. An example listing form is shown in Table 2-1, but there is no perfect form. The best form is one that is most convenient for the auditor and department.

Occasionally, a graph of labor information such as shown in Figure 2-2 can be very informative. From the information, one can generally determine labor resources used by each cost center and costs of such services to name but a few.

a. Labor Resource Model

With all this information, a labor resource model of the department under study can be drawn. From that model, potential areas for saving and additional work may be identified and ranked.

To draw a labor model Figure 2-3, start on the left side and indicate how much labor will be traced (in this case, 100% or 124 labor units, personnel authorized). The height of the diagram should be drawn to a scale that corresponds to the labor input (for example 1 inch = 50 persons). Draw the remainder of the diagram to the same scale and apportion input labor to the various uses. Note each time a labor resource is indicated, such as 75 percent in Figure 2-3, the diagram is reduced by the same amount. Figure 2-4 further illustrates this procedure.

TABLE 2-1

TYPICAL DEPARTMENT STAFFING AND BUDGET SPREAD SHEET

COMMAND: _____ REPORT NUMBER: _____

TYPE OF AUDIT: MICRO MICRO SURVEY SHEET _____ OF _____

DEPARTMENT: _____

POINT OF CONTACT: _____ TITLE: _____ PHONE: _____

COST CENTER: _____

POINT OF CONTACT: _____ TITLE: _____ PHONE: _____

AUDITOR: _____ TITLE: _____ PHONE: _____

ACTUAL START DATE: _____ ACTUAL COMPLETION DATE: _____

STAFFING TABLE: WAGES AND SALARIES FOR PUBLIC WORKS DEPARTMENT

POSITION TITLE	WORK/ COST CENTER	STATUS VACANT TEMP PERM	PD/JD	GRADE	FUND TYPE REIM APPR	SHIFT DAY	SHIFT AFT	SHIFT NIT	WAGES, DOLLARS PER HR	WAGES, OVERTIME PER DAY	WORK DAYS PER YR	ANNUAL WAGE DOLLARS	12 % BENEFITS	ANNUAL WAGE AND BENEFITS	SALARIED WORKERS DOLLARS PER YR	12 % SALARIED BENEFITS	SALARY AND BENEFITS	TOTAL ANNUAL COST, IN DOLLARS

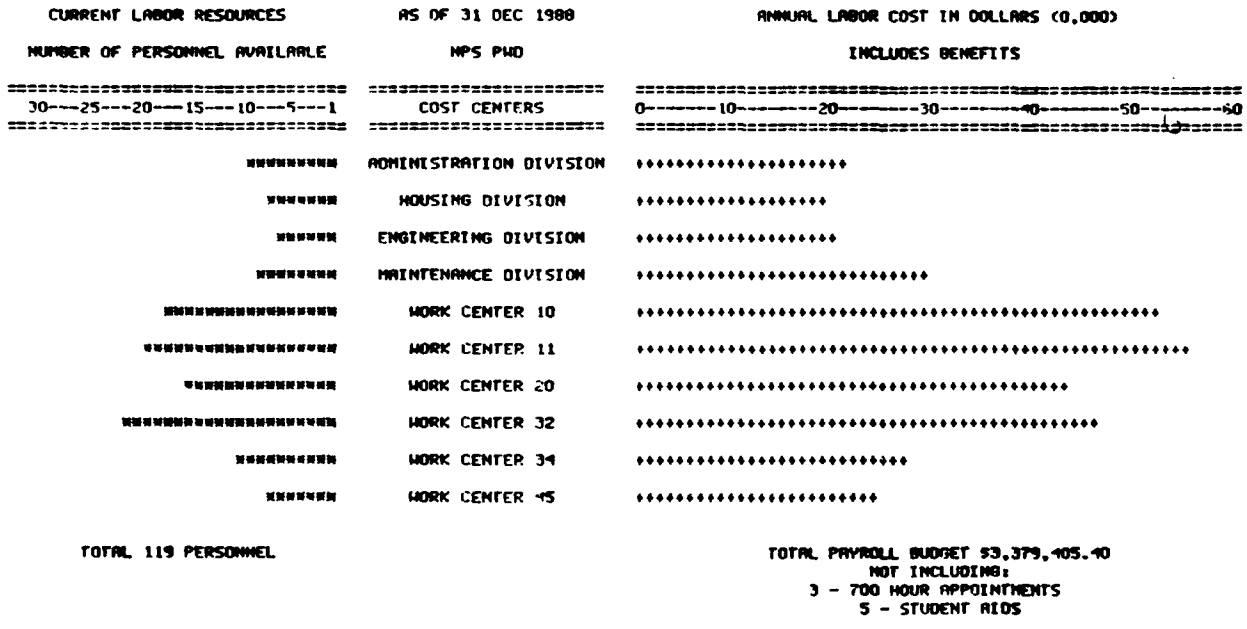


Figure 2-2 Labor Cost and Utilization of Available Resources

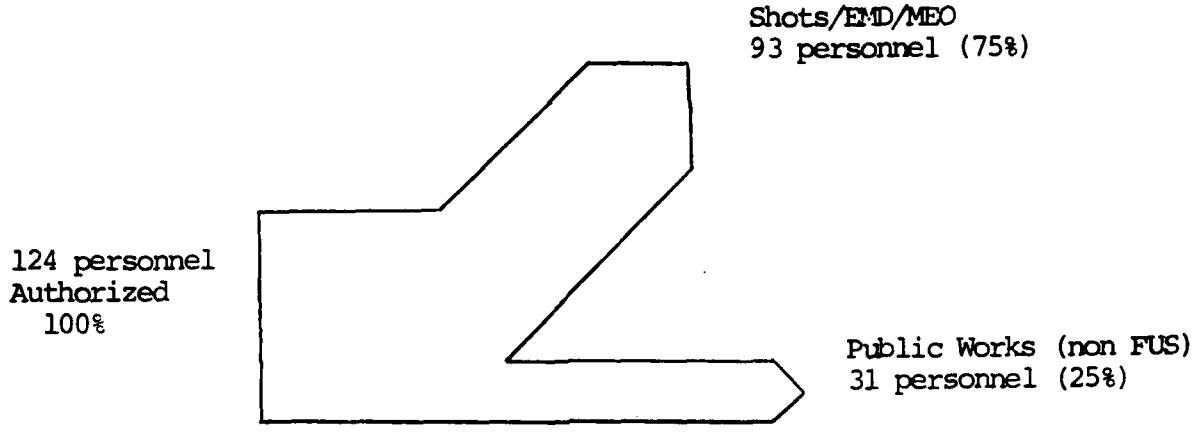


Figure 2-3 Authorized Department of Labor Model (Macro Analysis)

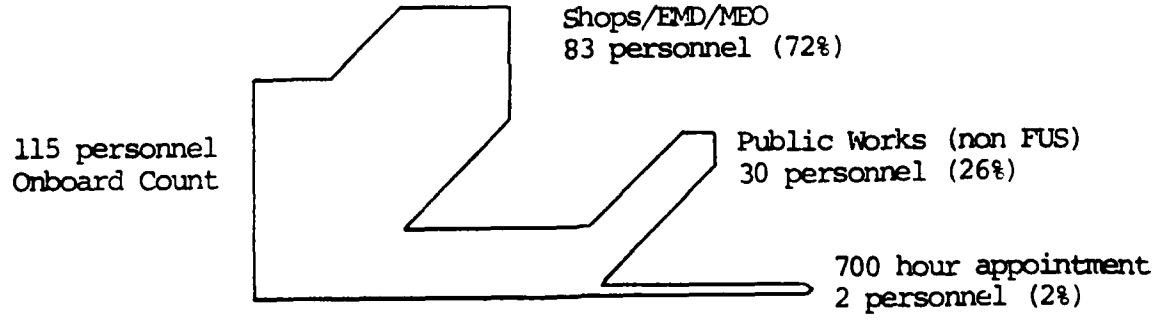


Figure 2-4 Onboard Department Labor Model (Macro Analysis)

b. Summary of Macro Audits

A macro audit, again, is a broad review of how labor is used in a department. It is designed to help focus efforts of investigators on areas of labor usage, in descending order from best to worst in the context of conservation.

The flowchart in Figure 2-5 illustrates steps in a macro audit. As noted earlier, a building block approach should be used in which the auditor chooses those blocks needed and builds a firm foundation for the entire labor resource identification program.

c. Notes of Caution

It is easy to jump into a micro audit from the start, particularly when an obvious labor or budget saving potential exists, such as duplicated services, or special controls techniques can be seen. Beware, however, that these obvious savings may be part of a system; the system may be in even worse shape and a single solution may be ill advised if the department or cost center has to undergo major changes.

Beware of accuracy for accuracy's sake. We often strive to be more accurate than is really justified. Labor resource auditing is much the same as a cost estimate; 90-95 percent of the problem can be handled with minimum effort and cost. The last five to ten percent, however, requires more funds and time than the first stage of the

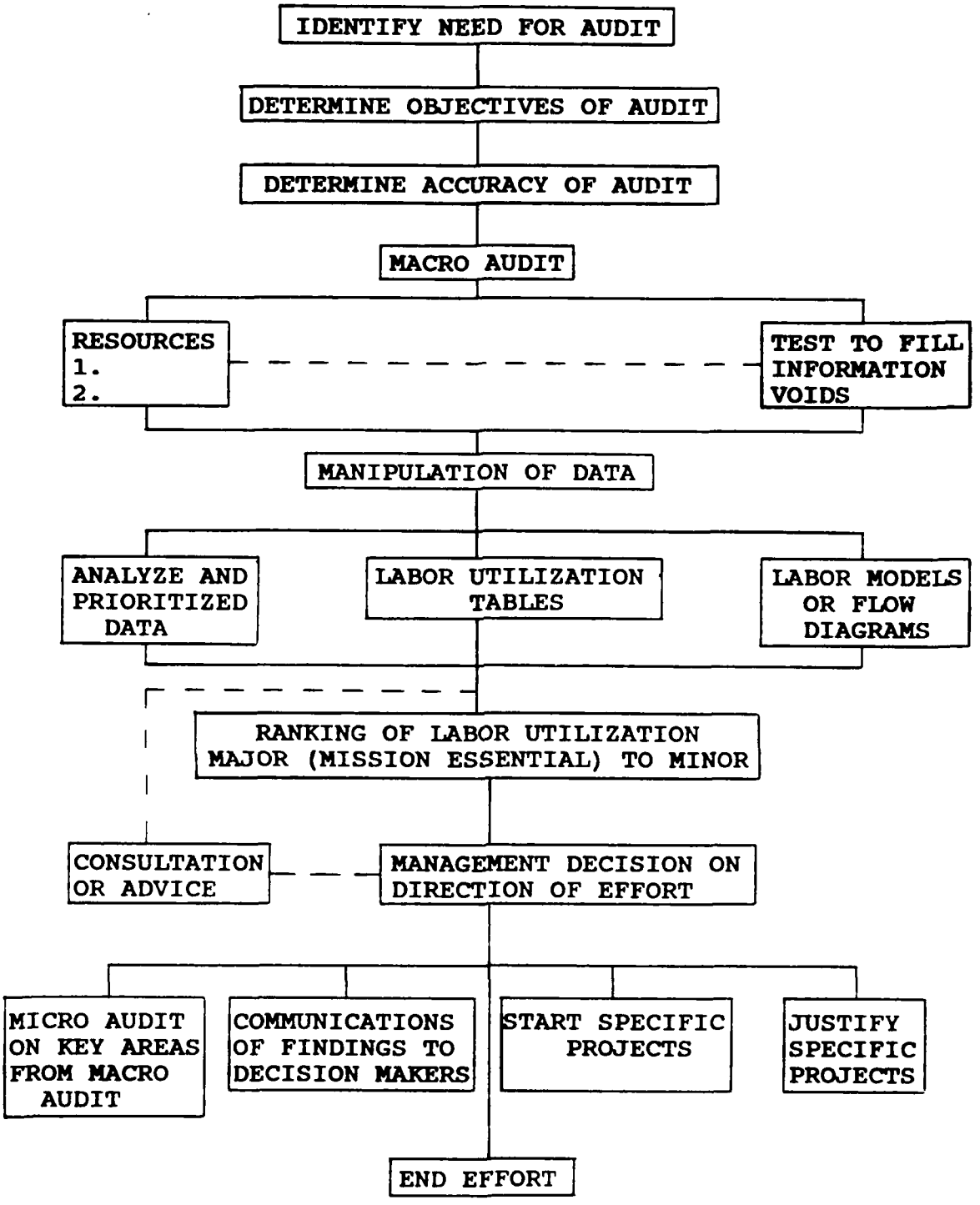


Figure 2-5 Flow Chart for a Labor Resource Audit

project. The key is for the auditor and department to determine how accurate they really have to be. Perhaps accuracy can be sacrificed in the macro audit and concentrated on a limited number of key areas for micro audits.

In general, each type of labor resource should be accounted for separately. For convenience, each labor type is converted to a common base, such as manhours or mandays. Occasionally, several labor types can be combined when they are all performing the same service, such as secretarial services.

3. The Micro Audit

A micro audit begins where a macro audit ends. Generally, the best way to start a micro audit is to review a macro audit and concentrate on areas of greatest labor use and potential savings.

a. Micro Audit Procedures

Begin by listing all labor and requirements in areas of interest. Separate military from civilian and white from blue collar workers. Include as much information as possible, practical, and useful, such as, name, grade, pay rate, task assignment, and so on. How this information is arranged is not of critical importance. A sample of one method is shown in Table 2-2. It is only important to collect what is needed and in a form which can be used.

Once this information is obtained, try to allocate annual labor use to various cost centers being studied.

TABLE 2-2

EXAMPLE OF DEPARTMENT STAFFING AND WAGE SPREAD SHEET

COMMAND: NAVAL POSTGRADUATE SCHOOL
TYPE OF SHEET: RECAP SHEET
DEPARTMENT: PUBLIC WORKS DEPARTMENT
POINT OF CONTACT: MS. JEROME BERTON — TITLE: ADMINISTRATIVE ASSISTANT — PHONE: (408) 646-2531
COST CENTER: WORK CENTER-MS/ADMINISTRATIVE CONTROL DIV.
POINT OF CONTACT: LCDR RICHARD GREENSHIRE, CEC, USN — TITLE: PUBLIC WORKS OFFICER — PHONE: AUTOVON 878-2531
AUDITOR: LT. LARRY J. ANSINS, CEC, USN — TITLE: STUDENT — PHONE: AUTOVON 878-2536
ACTUAL START DATE: 15 DECEMBER 1988 — ACTUAL COMPLETION DATE: 15 APRIL 1989
STAFFING TABLE: WAGES AND SALARIES FOR PUBLIC WORKS DEPARTMENT

REPORT NUMBER: MASTER THESIS
SHEET _____ OF _____

POSITION TITLE	WORK CNTR CENTER	STATUS VACANT TEMP PERM	PROJ	GRADE	FUND TYPE RSTR OPER	SHIFT NOV	SHIFT DEC	SHIFT MAY	WAGES, DOLLARS PER HR	WAGES, DOLLARS PER DAY	WORK DAYS PER YR	ANNUAL WAGE DOLLARS	12 % BENEFITS	ANNUAL WAGE AND BENEFITS	SALARIED SERVICES DOLLARS PER YR	12 % SALARIED BENEFITS	SALARY AND BENEFITS	TOTAL ANNUAL COST IN DOLLARS
TOOL ROOM MECH	WC-45	TEMP	R1079	WG-06	OPN				10.57	84.56	261	22,070.16	2,649.42	24,719.58				24,719.58
PRODUCTION CONTROLLER	WC-45	PERM	R1721	GS-09	OPN										27,026.00	3,243.12	30,269.12	30,269.12
PW GENERAL FOREMAN	WC-45	PERM	R0708	WS-10	OPN				19.00	152.64	261	39,839.04	4,780.68	44,619.72				44,619.72
PRODUCTION CONTROLLER	WC-45	PERM	R0779	GS-11	OPN										32,700.00	3,924.00	36,624.00	36,624.00
PW GENERAL FOREMAN	WC-45	PERM	R0784	WS-10	OPN				20.98	167.84	261	43,806.24	5,256.75	49,062.99				49,062.99
TOOL ROOM MECH	WC-45	TEMP/VAC	R1774	WG-08	OPN				11.64	93.52	0	0.00	0.00	0.00				0.00
PRODUCTION CONTROLLER	WC-45	TEMP	R0754	GS-09	OPEN										27,026.00	3,243.12	30,269.12	30,269.12
PRODUCTION CONTROLLER	WC-45	PERM	R1711	GS-09	OPN										25,943.00	1,913.16	17,856.16	17,856.16
*** TOTALS FOR WC-45 ***									62.32	498.56	83.00	$105,715.44	$12,685.04	$118,401.24	$108,699.00	$12,325.48	$118,810.48	$299,419.64
ACCOUNTING TECH	ADMIN	PERM	R1042	GS-04	OPN						261				25,943.00	1,913.16	17,856.16	17,856.16
ADMINISTRATIVE OFFICER	ADMIN	PERM	R1531	GS-09	OPN						261				27,026.00	3,243.12	30,269.12	30,269.12
FISCAL ACCT SPV	ADMIN	PERM	R1493	GS-07	OPN						261				22,093.00	2,651.16	24,744.16	24,744.16
BUDGET ANALYST	ADMIN	PERM	R1478	GS-09	OPN						261				17,830.00	2,140.56	19,970.56	19,970.56
CLERK TYPIST	ADMIN	PERM	R1041	GS-04	OPN						261				25,943.00	1,913.16	17,856.16	17,856.16
ACCOUNTING TECH	ADMIN	PERM	R1512	GS-05	OPN						261				17,830.00	2,140.56	19,970.56	19,970.56
CLERK TYPIST	ADMIN	TEMP	R1041	GS-04	OPEN						261				25,943.00	1,913.16	17,856.16	17,856.16
COMPUTER SPECIALIST	ADMIN	PERM	R1051	GS-11	OPN						261				32,700.00	3,924.00	36,624.00	36,624.00
*** TOTALS FOR ADMIN ***									00.00	00.00	2,088.00	00.00	00.00	00.00	$180,324.00	$19,838.88	$180,162.88	$180,162.88
CONTRACT SURV REP	RCD	PERM	R1371	GS-10	OPN						261				29,761.00	3,571.32	33,332.32	33,332.32
PLANNER & ESTIMATOR	RCD	PERM	R1414	WG-08	OPN				15.50	124.64	261	32,531.04	3,903.72	36,434.76				36,434.76
PLANNER & ESTIMATOR	RCD	PERM	R0994	WG-10	OPN				15.50	124.64	261	32,531.04	3,903.72	36,434.76				36,434.76
PLANNER & ESTIMATOR	RCD	PERM	R0998	WG-10	OPN				15.50	124.64	261	32,531.04	3,903.72	36,434.76				36,434.76
PLANNER & ESTIMATOR	RCD	PERM	R0995	WG-10	OPN				15.50	124.64	261	32,531.04	3,903.72	36,434.76				36,434.76
CONTRACT SURV REP	RCD	PERM	R1371	GS-09	OPN						261				27,026.00	3,243.12	30,269.12	30,269.12
SPVY ARCHITECT	RCD	PERM	R2399	GS-12	OPN						261				39,192.00	4,703.04	43,895.04	43,895.04
PLANNER & ESTIMATOR	RCD	TEMP	R0993	WG-10	OPN				15.50	124.64	261	32,531.04	3,903.72	36,434.76				36,434.76
*** TOTALS FOR RCD ***									77.50	623.20	2,088.00	$162,655.20	$19,516.62	$182,171.82	$95,979.00	$11,517.48	$107,496.48	$289,670.30

Often this can be done by observing how a process is done, correlating that production process to labor use, and then expanding this to annual usage. Once a cost center's labor use is balanced, examine the results and concentrate further studies where there is the greatest potential for savings within the area.

Again, this is a step-by-step process that takes the auditor logically through the labor usage maze. It can be compared to finding first the earth, then the continent, the country, the city, the street, and finally, an address on that street. The whole procedure is one of selection and refinement. We take the labor resource balance of the activity and proceed each time to the next less complicated but more technical level. Eventually, we will arrive at the individual person doing the task.

b. Labor Resource Model

Figures 2-6 and 2-7 are examples of a micro audit labor model. From available labor resources determined in a macro audit 115 labor units are expended in the day to day operations of the department. The departmental needs were determined in the micro audit to be 124 labor units. The labor loss (or additional labor requirements) were then calculated to be nine labor units by subtracting available labor needs from the 124 units authorized.

By drawing such a diagram, managers actually see major areas of concern and improve chances of concentrating

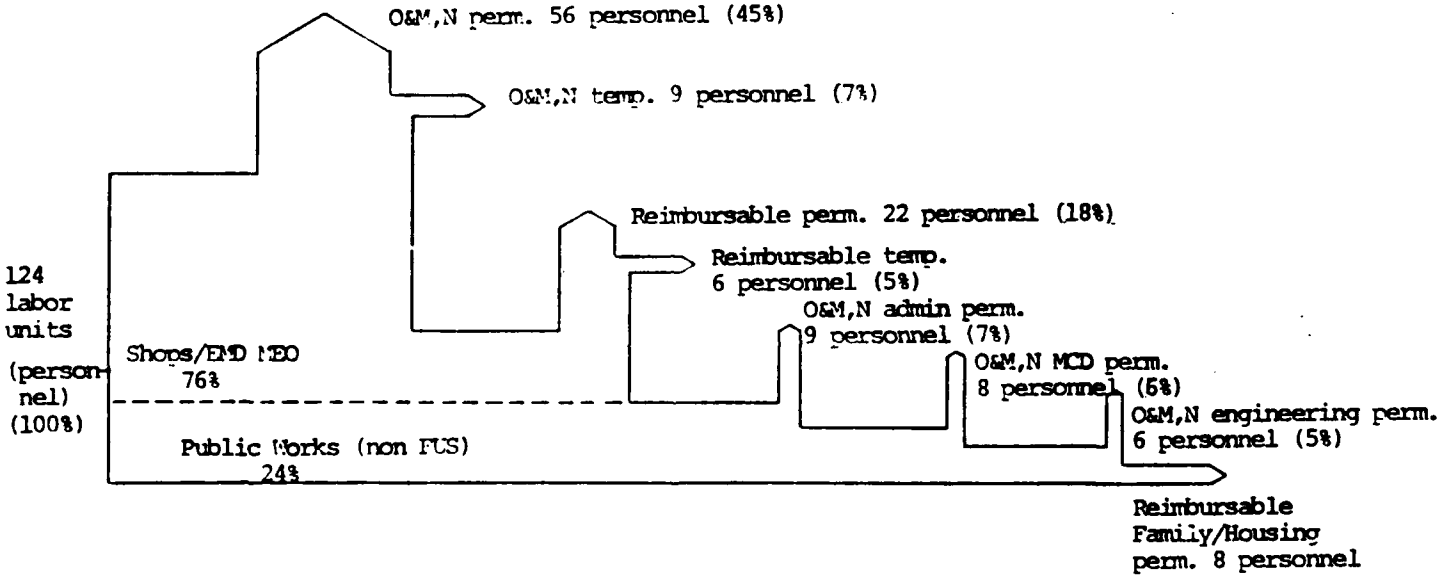


Figure 2-6 Authorized Department Labor Model (Micro Analysis)

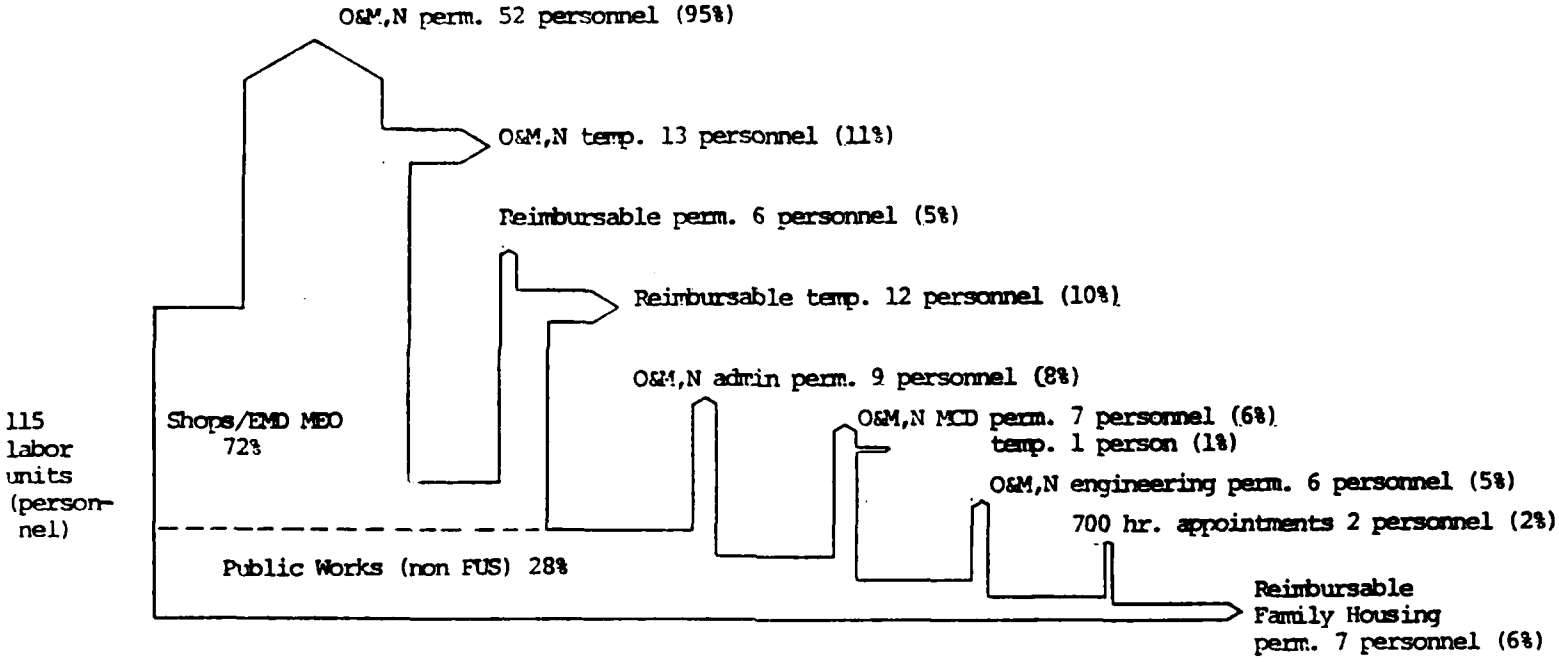


Figure 2-7 Onboard Department Labor Model (Micro Analysis)

efforts where they will do the most good. In addition, once the above information is known, a model of the process under ideal conditions can be developed. By comparing the actual diagram to the ideal, managers can further improve chances of maximizing labor savings while minimizing investments. These labor flow diagrams are useful in explaining the significance of budget cuts, impact on mission performance, and specific areas affected.

c. End Notes on Micro Audit

A micro audit helps identify the best solutions and quantifies results. Almost all other methods are hit-and-miss and often lead to poor decisions.

One final note on this subject: a micro audit may raise some questions an auditor is not able to answer. Do not be afraid to call on experts for outside help. Consultants, either from within or external to the command are best used to help with defined problems. They should not be called in to do all the work but only to advise on difficult problems. After all, the only program that will be successful in the department is yours, because, you have a reason for making it work properly.

III. PROJECT PLANNING

Project planning provides a framework for the labor resource audit. The importance of planning before an audit cannot be overemphasized. Labor resource audits can be a complex and time consuming process in which individuals from various disciplines are involved. It is imperative that an auditor prepare complete project plans which assign responsibilities and provide work statement and schedules to all concerned. Planning for an audit consists of defining the objectives and scope of the audit, dividing the command, department or division, and assigning survey and analysis tasks.

A. DEFINING THE OBJECTIVES

Labor resource audits may be preliminary or detailed. It may be the initial audit or a routine audit. Its purpose may be to develop standards and/or set labor and budget goals. It may deal with identifying obvious wastage or analyzing affects of certain procedure modifications. An explicit statement of audit objectives must be made. Based on these objectives, the labor resource analysis team can plan the division of departments, divisions, or cost center, and assignment of individuals. A statement of audit objectives should include the purpose of the audit (to establish performance standards, to identify and analyze

labor saving opportunities, identify critical mission tasks, or to conduct an annual examination of existing resources in anticipation of a reduction in labor force or budget cuts), the description of the cost center to be audited (whole departments or certain cost centers or processes), and the scope of the analysis (detailed analysis of labor use, of certain processes, or an analysis of procedural improvements).

B. DIVIDING THE COMMAND

Having defined the objectives of the labor resource audit, the next step is to determine how to divide the command, department, or cost centers. A system for accountability of labor costs and production standards will be based on a labor cost center. A labor cost center is the smallest segment department, division, or subdivision of the command for which actual labor consumption can be measured, and which can be held accountable for its labor use. Measurability and accountability are the key concepts in this definition.

Depending on the degree of control and monitoring, the auditor should divide the command into as many cost centers as possible. In general, the finer the division, the more effective the program is. For example, if it were possible to set up sufficient controls so that each department could be made into a labor cost center, then every department could be held directly accountable for its labor use. In

this instance, the department manager would see the direct effect of labor costs for the department. If three or four departments were included in one cost center, then the manager of each department would feel only partially responsible for labor use. The auditor should decide on approaches which will best show labor usage and provide opportunity for reduction of labor costs.

A command may be divided into labor cost centers by department, division, process, and/or type of service. Listed below are a few guidelines an auditor should consider while making the final decision.

- Each department, division or work center may be treated as a labor cost center.
- The cost centers should be the smallest manageable segment of the command.
- The cost centers should be mutually exclusive and exhaustive, i.e., every labor cost charged must be accounted for.
- There should be only one individual responsible for the performance of a cost center.
- The cost of labor applied (or charged) to each cost center should be a direct measure of consumption. If this is not possible, an equitable and agreeable procedure for allocation of labor costs should be worked out.
- The number of cost centers should be kept within a certain limit so that the paperwork and coordination problems do not become insurmountable.

C. ASSIGNING THE SURVEY AND ANALYSIS TASKS

The survey team is responsible for collecting labor use data and identifying opportunities. Members visit the

department, identify improvements, and prepare an implementation schedule in coordination with the operating personnel.

The analysis team will work with the data collected by the survey team. The analysis team calculates labor balances and efficiencies, develops labor standards, and analyzes labor cost saving opportunities. This team is also responsible for preparing the final audit report. The number and type of personnel needed for this team will depend on the size and nature of the command.

D. LABOR MANAGERS

Labor management is a command (team) effort. Many people are involved in the allocation and use of labor resources, but few are involved in labor resource conservation. A well-considered and managed labor resource program must involve senior management and administrators with policy decisions, professionals in consultation, and most especially personnel who actually perform the task and end users who by their support or lack of it can make a program work or make it worthless.

E. BUILDING THE PROGRAM

Many labor resource saving and efficiency proposals fail to be implemented because decision makers fail to understand what is being proposed and its real value to a command. This section will illustrate several ways for management to

implement labor resource macro audits and micro audits and convey information to personnel or other people within a cost center who may be less familiar with the process. Many of the techniques involve use of simple graphical modeling tied to concise executive communication techniques. All the methods stress the importance of understanding labor utilization in effecting a successful conservation program.

1. Select the Objectives

Objectives chosen for the labor audit should be consistent with the command's interests and resources. An objective can be defined as the means to the end result. This end result is the output of the auditor's planning process. Establishing a meaningful objective is usually a very difficult step in the planning process. The reason is that it is easy to get sidetracked into related areas and never establish the objective. Also, the objectives are only a means to the results, not the results themselves. Frequently it is found that objectives are not met because all the emphasis was placed on establishing objectives not accomplishing them. Establishment and accomplishment of objectives go hand-in-hand. In general, good objectives can be characterized as follows:

- Objectives must be tangible. An objective is intended to provide clear direction to the organization and its people toward an end result which is defined. It is important that an objective leave no doubt as to what is intended, how it will be achieved, and when the result will be accomplished. Therefore, an objective should:

a. State the desired result.

b. Specify the conditions under which those concerned must operate.

c. Specify the tests by which the end result will be measured.

- Objectives must relate directly to those they affect. To establish objectives that do not relate to the organization is useless. For example, for an auditor of a PWD on a military installation to establish a profit-oriented objective would serve little purpose.

- Objectives must be realistic. To motivate, an objective must be within reach. It may require a difficult climb, not an impossible one.

- Objectives must relate to each other. Abstract goals are worse than no goals at all. If the goal is simply "increase productivity," what does it mean? Such a goal only serves to frustrate those it was intended to assist or guide.

2. Establish a Labor Utilization and Budget Profile

Billet listings provide information such as work center code (cost center locator), position status (permanent, temporary or vacant), funding type (operations or reimbursable), position and job descriptions numbers, individuals name, position title, and pay grade. This information is available from the Personnel Department or the department's Administrative Assistant. Information may be in the form such as shown in Table 3-1.

The billet listing provides a general picture of labor resources available in a particular department and cost center; it cannot, however, indicate variation of labor resources experienced within a cost center. Knowledge of how local conditions work and personal skills should be used

TABLE 3-1

PUBLIC WORKS BILLET LISTING--MEO--STATUS
AS OF 30 DECEMBER 88

WANG 0083P

SAG	CODE	POS STAT	FUND	PD/JD	NAME	POSITION TITLE	PLAN	GRADE	REMARKS
A/V	431-10	PERM	0	A1231		ELEC WORKER	WG-2604	08	
A/V	431-10	PERM	0	A1231		~~ELEC WORKER~~	WG-2604	08	
FA	431-10	PERM	0	A0115		MAINT MECH LEADER	WL-4749	11	Temp promotion 01-09-89
FA	431-10	PERM	0	A0821		MAINT MECH	WG-4749	10	Temp promotion 02-09-89
FA	431-10	PERM	0	A0787		MAINT FOREMAN	WS-4701	14	Temp promotion 01-09-89
FA	431-10	PERM	0	A0820		MAINT MECH	WG-4749	10	
FA	431-10	PERM	0	A0816		ELEV MECH	WG-5313	11	
FA	431-10	PERM	0	A0820		MAINT MECH	WG-4749	10	
FA	431-10	PERM	0	A0831		A/C EQUIP MECH	WG-5306	11	
FA	431-10	PERM	0	A0815		DIGITGAL COMP (ELVI)	WG-2608	12	
FA	431-10	TEMP	0	A0815		DIGITAL COMP MECH	WG-2608	12	
FC	431-10	PERM	0	A0818		BOILER PLT OP	WG-5402	10	
FC	431-10	TEMP	0	A0818		BOILER PLT OP	WG-5402	10	10-22-89
FC	431-10	PERM	0	A0818		BOILER PLT OP	WG-5402	10	
FC	431-10	PERM	0	A0818		BOILER PLANT OP	WG-5402	10	
FC	431-10	PERM	0	A0818		BOILER PLT OP	WG-5402	10	
FA	431-10	PERM	R	A0832		A/C EQUIP MECH	WG-5306	08	
FC	431-10	PERM	0	A0818.5		BOILER PLT OP	WG-5402	10	
FA	431-11	TEMP	0	A0804		PLUMBER	WG-4206	09	
FA	431-11	PERM	0	A0922		ELECTRICIAN	WG-2805	11	
FA	431-11	PERM	0	A0802		LOCKSMITH	WG-4804	09	
FA	431-11	PERM	0	A0789		MAINT FOREMAN	WS-4701	10	
FA	431-11	PERM	0	A1599		MAINT MECH	WG-4749	07	
FA	431-11	PERM	0	A0801		ELECTRICIAN	WG-2805	10	
FA	431-11	PERM	0	A0803		MAINT MECH	WG-4749	09	
FA	431-11	PERM	0	A1286		LOCKSMITH	WG-4804	09	
FA	431-11	PERM	0	A0898		MAINT MECH LDR	WL-4749	10	
FA	431-11	PERM	0	A0803.1		MAINT MECH	WG-4749	09	
FA	431-11	TEMP	R	A0807		GEN HELPER	WG-4701	05	02-27-89
FA	431-11	PERM	0	A0801		ELECTRICIAN	WG-2805	10	
FA	431-11	PERM	0	A0801		ELECTRICIAN	WG-2805	10	
FA	431-11	PERM	R	A0803		MAINT MECH	WG-4749	09	
FA	431-11	TEMP	R	A0807		GEN HELPER	WG-4701	05	03-06-89
FA	431-11	TEMP	R	A0801		ELECTRICIAN	WG-2805	10	02-07-89
FA	431-11	PERM	R	A1104		MAINT MECH LDR	WL-4749	10	

to modify general conditions when more precise answers are required. For example, if an individual is classified as a laborer/general helper and has also cross-trained as a carpenter or acquired special skills through on-job-training, then the billet listing should be modified accordingly. Only through this procedure can actual skills and resources available to a cost center be identified and fully utilized.

From the Comptroller Department the auditor should acquire the current General Schedule Pay Chart (GS workers), Table 3-2, and the local Schedule of Wages (Wage Grade, Wage Leader, and Wage Supervisor Rates), Table 3-3. In addition the auditor should inquire about the percent of annual benefits and average grade level used by the Comptroller Department in estimating the labor budget of the activity. For example, at the NPS the Public Works Administrative Assistant uses the following guidelines: For General Schedule Employees (Salary) the grade step used for estimating the budget is five, and benefits are calculated at 12 percent. For Wage Grade Employees (Hourly) the grade step used for estimating the budget is three, and benefits are calculated at 12 percent.

From the above information the auditor is able to identify labor resources available within a cost center, estimate the cost of labor by cost center, and provide a total yearly budget as shown in Table 3-4.

TABLE 3-2

JANUARY 1989 GENERAL SCHEDULE PAY CHART

	1	2	3	4	5	6	7	8	9	10
GS-1	$10,213	$10,555	$10,894	$11,233	$11,573	$11,773	$12,108	$12,445	$12,461	$12,780
2	11,484	11,757	12,137	12,461	12,601	12,972	13,343	13,714	14,085	14,456
3	12,531	12,949	13,367	13,785	14,203	14,621	15,039	15,457	15,875	16,293
4	14,067	14,536	15,005	15,474	15,943	16,412	16,881	17,350	17,819	18,288
5	15,738	16,263	16,788	17,313	17,838	18,363	18,888	19,413	19,938	20,463
6	17,542	18,127	18,712	19,297	19,882	20,467	21,052	21,637	22,222	22,807
7	19,493	20,143	20,793	21,443	22,093	22,743	23,393	24,043	24,693	25,343
8	21,590	22,310	23,030	23,750	24,470	25,190	25,910	26,630	27,350	28,070
9	23,846	24,641	25,436	26,231	27,026	27,821	28,616	29,411	30,206	31,001
10	26,261	27,136	28,011	28,886	29,761	30,636	31,511	32,386	33,261	34,136
11	28,852	29,814	30,776	31,738	32,700	33,662	34,624	35,586	36,548	37,510
12	34,580	35,733	36,886	38,039	39,192	40,345	41,498	42,651	43,804	44,957
13	41,121	42,492	43,863	45,234	46,605	47,976	49,347	50,714	52,089	53,460
14	48,592	50,212	51,832	53,452	55,072	56,692	58,312	59,932	61,552	63,172
15	57,158	59,063	60,968	62,873	64,778	66,683	68,588	70,493	72,398	74,303
16	67,038	69,273	71,508	73,743	75,423	76,678	78,869	81,060	82,500	
17	76,400	78,956	82,122	82,500	83,813					
18	86,682									

TABLE 3-3

DEPARTMENT OF DEFENSE WAGE GRADE PAY SCHEDULE FOR MONTEREY, CALIFORNIA (ISSUE DATE 19 APRIL 1988)

	WG-RATES					WL-RATES					WS-WD-WN RATES				
GRADE	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
1	7.06	7.36	7.65	7.95	8.25	7.78	8.09	8.41	8.76	9.06	10.62	11.06	11.50	11.95	12.39
2	7.58	7.92	8.25	8.56	8.27	8.35	8.71	9.05	9.41	9.76	11.15	11.63	12.09	12.56	13.04
3	8.12	8.48	8.83	9.15	9.50	8.94	9.33	9.70	10.07	10.44	11.69	12.19	12.68	13.16	13.67
4	8.64	9.01	9.37	9.75	10.09	9.54	9.94	10.34	10.74	11.12	12.21	12.73	13.22	13.74	14.24
5	9.20	9.57	9.96	10.35	10.74	10.11	10.54	10.96	11.39	11.82	12.77	13.29	13.82	14.36	14.89
6	9.75	10.13	10.57	10.96	11.37	10.73	11.71	11.62	12.07	12.51	13.31	13.87	14.43	14.98	15.51
7	10.29	10.68	11.11	11.56	11.97	11.32	11.77	12.24	12.73	13.18	13.82	14.42	14.99	15.57	16.13
8	10.79	11.25	11.69	12.15	12.60	11.89	12.38	12.87	13.39	13.88	14.37	14.98	15.58	16.18	16.77
9	11.35	11.82	12.28	12.77	13.22	12.48	13.00	13.51	14.04	15.55	14.91	15.51	16.13	16.77	17.39
10	11.87	12.36	12.85	13.36	13.86	13.05	13.59	14.14	14.68	15.22	15.44	16.06	16.71	17.37	18.02
11	12.40	12.92	13.44	13.95	14.48	13.63	14.20	14.77	15.34	15.93	15.79	16.47	17.12	17.77	18.44
12	12.94	13.48	14.03	14.56	15.11	14.24	14.84	15.44	16.03	16.62	16.28	16.96	17.63	18.32	19.00
13	13.35	13.90	14.46	15.01	15.57	14.67	15.28	15.90	16.51	17.12	16.89	17.59	18.29	19.01	19.70
14	13.73	14.30	14.87	15.45	16.01	15.10	15.72	16.36	16.99	17.62	17.60	18.34	19.08	19.80	20.55
15	14.12	14.71	15.30	15.89	16.48	15.53	16.18	16.84	17.47	18.12	18.43	19.19	19.98	20.73	21.51
										WS-16	19.38	20.17	20.98	21.80	22.60
										WS-17	20.44	21.28	22.14	23.00	23.84
										WS-18	21.60	22.51	23.40	24.31	25.22
										WS-19	22.88	23.86	24.79	25.75	26.70

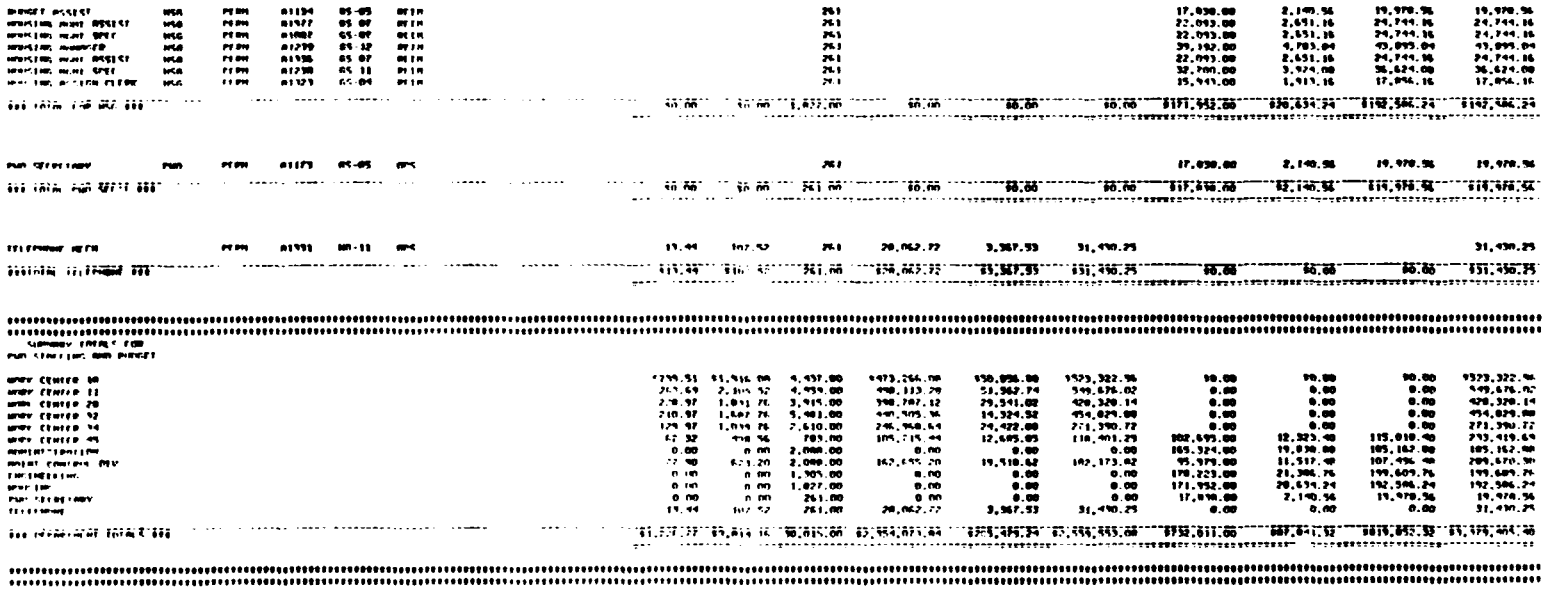
TABLE 3-4

NPS PWD STAFFING AND BUDGET SPREAD SHEET
STATUS AS OF 30 DECEMBER 1988

TABLE 3-4 (Cont'd)

TABLE 3-4 (Cont'd)

TABLE 3-4 (Cont'd)



3. Establish Productivity and Labor Resource Profile

Productivity is the ratio between output and input; in practical terms, it is the ratio between the amount produced and the amount of all resources used in the course of production; or it could be a variance from planned to actual.

Historical information currently stored in the BEST system data base are not maintained or, if maintained, they are not in proper data field format to determine variances, or backlog for management. Information such as: length of time a work request has been in the system, labor, material, and total project cost variances can not be provided in a timely manner. In addition, current information necessary to efficiently and effectively manage the total backlog broken down by labor and material availability is also non existent. However, through computer program modifications external to the BEST system, such information becomes available for management review, and assists shop supervisors in planning, scheduling, and identifying resource availability (labor and material). Programs listed below were developed to interact with the BEST system and are available in the appendices of this thesis. All programs have been tested and used to acquire actual data to support this thesis. However, use of these programs and results obtained by another PWD will be only as good as the data base that is contained in the individual BEST system.

Programs developed by the author of this thesis to interact with the BEST system are:

- Variance report on length of time a work request has been in the system before completion. See Figure 3-1 for output and Appendix A for program code.
- Variance report on estimated versus actual labor costs. See Figure 3-2 for output and Appendix B for program code.
- Variance report on estimated labor hours versus actual labor hours. See Figure 3-3 for output and Appendix C for program code.
- Variance report on estimated material costs versus actual material costs. See Figure 3-4 for output and Appendix D for program code.
- Variance report on estimated total project cost versus actual project costs. See Figure 3-5 for output and Appendix E for program code.
- Backlog of work requests broken down by work centers and trade awaiting material. See Figure 3-6 for output and Appendix F for program code.
- Backlog of work requests broken down by work centers and trade awaiting labor. See Figure 3-7 for output and Appendix G for program code.

All variance reports are sorted by priority, facility number, and two general categories; minor or specific work requests. The general categories are further subdivided and categorized by whether a work request is alteration, improvement, repair, or maintenance.

These reports are useful for upper level management in analysis of: variances, flow of funds to each facility, category and subdivision of work, and to monitor work priority. In addition, such reports provide justification for further analysis in specific areas should problems be

PRI CODE	CUST CODE	FACILITY NUMBER	RM NUMBER	JOB NUMBER	JOB DESCRIPTION	DATE REQUESTED	SHOP COMPL	TOTAL DAYS IN SYSTEM
1	FNOC	15	FNOC7299	BBR701	BLDG 15, RM 108, CONSTRUCT WALLS, ETC.	870928	880120	112
1	FNOC	15	FNOC8106	BRR641	B15, REPLACE CARPET IN RMS 1088, 108C AND 1080	880112	880325	74
1	NEPP	15	NEPP8032	BFF913	BLDG.15(ROOMS 200,202,& 202A)SMOKE OUT DRAIN LINES	880304	880325	21
1	036	200	200-8027	BFF278	REMOVE OLD AND INSTALL NEW WATER TEMP CONTROLLER RM. 107	880428	880516	18
1	441	200	200-8004	BFF211	RM 201 BRR-RPL CARPET, REPAINT WALLS	871203	880512	160
1	441	200	200-8005	BFXC32	MAKE TWO SIDED SIGNS WITH ARROWS POINTED IN BOTH DIRECTIONS	871215	880325	100
1	441	200	200-8006	BFF210	RM 201 - PREPARE SPACE FOR BASE SECURITY MOVE	880111	880512	123
1	491	209	209-8006	BFF220	SWIMMING POOL - PURCHASE & INSTALL CHLORINATOR	880219	880517	89
1	67	214	214-8007		NEED 30 YRD TRASH BOX NERO SHOP	880405	880516	41
1	67	215	215-8009	BFF924	DRAIN AND CLEAN COOLING TOWER BEHIND BLDG. 215	880804	881019	76
1	439	216	216-8001	BFMC31	REPAIR ROOF B216	880112	880325	74
1	001	220	220-8079		CLEAN QUARTERDECK LOUNGE AREA AND FLOORS, POLISH & BUFF	871120	880112	51
1	002	220	220-7485	BFTC31	INSTALL SHELVING ALL THE WAY AROUND RMS 135A & 135D	870818	880224	187
1	002	220	220-8271	BFF275	STRING LOCAL NETWORK CABLE FROM RM 135C TO E104	880420	881014	177

Figure 3-1 Variance Report on Length of Time a Work Request Has Been in the System Before it Was Completed. This Will Show All Work Requests Before the Date of December 5, 1988

RM NUMBER	FACILITY NUMBER	JOB NUMBER	JOB DESCRIPTION 26 CHAR	CUST PRI	LC	JOB STATUS	MP/RUSH CODE	TOT EST LABOR COST	TOT ACTUAL LABOR COST	LABOR COST	TOTAL DAYS IN SYSTEM
220-7485	220	BFTC31	INSTALL SHELVING ALL THE W	1	06	MINOR	A	945	1078	133.00	187
231-8047	231	BFTC34	RM 337 - INSTALL 3PH 120	1	06	MINOR	A	500	650	90.00	71
235-8035	235	BFTC42	RMS 107 &108 - INSTALL 1"	1	06	MINOR	A	450	401	-49.00	120
330-7209	330	BFTC35	REQUEST BOOKSHELVES AND BR	1	06	MINOR	A	175	175	0.00	195
330-8073	330	BFTC38	BLDG 330 PENTHOUSE - INSTA	1	06	MINOR	A	1060	1589	529.00	85
330-8097	330	BFTC40	CONNECT I-156 TO I-224 WIT	1	06	MINOR	A	201	201	0.00	46
234-6124	234	BFTC02	B 234 - INSTALL WARNING LI	2	06	MINOR	A	200	401	201.00	548
234-8027	234	BFTC46	INSTALL 350 YD COAXIAL CAB	2	06	COMPLETE	A	1192	1103	-89.00	63
234-6125	234	BFTC08	INSTALL THREE EMERGENCY CU	3	06	MINOR	A	601	1078	477.00	573
235-7121	235	BFTC25	INSTALL CONDUIT FROM MPTV	3	06	MINOR	A	275	251	-24.00	312
235-8058	235	BFTC44	RESTROOM 108 - DIVIDE FOR M	3	06	COMPLETE	A	100	100	0.00	53
MISC7.12	336	BFTC07	INST 5 SMOKE DETECTORS W/S	3	06	MINOR	A	451	194	-257.00	284
427-7000	427	BFTC26	BLDG 427 - INSTALL PERSONN	3	06	MINOR	A	300	301	1.00	354
429-8003	429	BFTC36	INSTALL METAL SHED NEXT TO	3	06	MINOR	A	1806	2005	199.00	48

Figure 3-2 Total Cost for Labor and the Variances of Labor Sorted by Buildings

PW NUMBER	FACILITY NUMBER	JOB NUMBER	JOB DESCRIPTION 26 CHARS	CUST PRI	LC	JOB STATUS	MR/A/I CODE	TOT EST LABOR HRS	TOT ACTUAL LABOR HRS	LABOR HRS	TOTAL DAY IN SYSTEM
220-7485	220	BFTC31	INSTALL SHELVING ALL THE W	1	06	MINOR	A	84	86	2.00	187
232-8062	232	BFTC34	RM 330 - INSTALL 30A, 120V	1	06	MINOR	A	40	48	8.00	73
235-8039	235	BFTC42	RMS 107 &109 - INSTALL 1"	1	06	MINOR	A	36	32	-4.00	120
330-7209	330	BFTC35	REQUEST BOOKSHELVES AND BR	1	06	MINOR	A	14	14	0.00	195
330-8073	330	BFTC38	BLDG 330 PENTHOUSE - INSTA	1	06	MINOR	A	80	120	40.00	85
330-8097	330	BFTC40	CONNECT I-158 TO I-224 WIT	1	06	MINOR	A	16	16	0.00	46
234-6124	234	BFTC02	B 234 - INSTALL WARNING LI	2	06	MINOR	A	16	32	16.00	548
234-8027	234	BFTC46	INSTALL 350 YD COAXIAL CAB	2	06	COMPLETE	A	112	88	-24.00	63
234-6125	234	BFTC08	INSTALL THREE EMERGENCY CU	3	06	MINOR	A	48	86	38.00	573
235-7121	235	BFTC25	INSTALL CONDUIT FROM MPTU	3	06	MINOR	A	22	20	-2.00	312
235-8058	235	BFTC44	RESTROOM 105 - DIVIDE FOR M	3	06	COMPLETE	A	8	8	0.00	53
MISC7112	336	BFTC07	INST 5 SMOKE DETECTORS W/S	3	06	MINOR	A	32	18	-14.00	284
427-7000	427	BFTC26	BLDG 427 - INSTALL PERSONN	3	06	MINOR	A	24	24	0.00	354
428-8003	428	BFTC36	INSTALL METAL SHED NEXT TO	3	06	MINOR	A	144	160	16.00	48

Figure 3-3 Total Labor Hours and the Variances of Labor Hours Sorted by Maintenance and Repair

PW NUMBER	FACILITY NUMBER	JOB NUMBER	JOB DESCRIPTION 26 CHARS	CUST PRI	LC	JOB STATUS	MR/A/I CODE	TOT EST MAT COST	TOT ACTUAL MAT COST	MATERIAL	TOTAL DAY IN SYSTEM
220-7485	220	BFTC31	INSTALL SHELVING ALL THE W	1	06	MINOR	A	710	739	29.00	187
232-8062	232	BFTC34	RM 330 - INSTALL 30A, 120V	1	06	MINOR	A	152	15	-137.00	73
235-8039	235	BFTC42	RMS 107 &109 - INSTALL 1"	1	06	MINOR	A	200	103	-97.00	120
330-7209	330	BFTC35	REQUEST BOOKSHELVES AND BR	1	06	MINOR	A	115	141	26.00	195
330-8097	330	BFTC40	CONNECT I-158 TO I-224 WIT	1	06	MINOR	A	20	4	-16.00	46
234-6124	234	BFTC02	B 234 - INSTALL WARNING LI	2	06	MINOR	A	700	1000	300.00	548
234-8027	234	BFTC46	INSTALL 350 YD COAXIAL CAB	2	06	COMPLETE	A	100	0	-100.00	63
234-6125	234	BFTC08	INSTALL THREE EMERGENCY CU	3	06	MINOR	A	243	10	-233.00	573
235-7121	235	BFTC25	INSTALL CONDUIT FROM MPTU	3	06	MINOR	A	150	98	-52.00	312
235-8058	235	BFTC44	RESTROOM 105 - DIVIDE FOR M	3	06	COMPLETE	A	200	99	-101.00	53
MISC7112	336	BFTC07	INST 5 SMOKE DETECTORS W/S	3	06	MINOR	A	938	839	-99.00	284

Figure 3-4 Total Cost for Material and the Variances of Material Sorted by Buildings

PM NUMBER	FACILITY NUMBER	JOB NUMBER	JOB DESCRIPTION 26 CHARS	CUST PRI	LC	JOB STATUS	MR/A/I CODE	TOT EST COST	TOT ACTUAL COST	TOTAL COST	TOTAL DAY IN SYSTEM
220-7485	220	@FTC31	INSTALL SHELVING ALL THE W	1	06	MINOR	A	1832	1817	-15.00	187
232-8062	232	@FTC34	RM 330 - INSTALL 30A, 120V	1	06	MINOR	A	735	616	-119.00	73
235-6039	235	@FTC42	RMS 107 &109 - INSTALL I"	1	06	MINOR	A	735	504	-231.00	120
330-7209	330	@FTC35	REQUEST BOOKSHELVES AND BR	1	06	MINOR	A	330	316	-14.00	195
330-8073	330	@FTC38	BLDG 330 PENTHOUSE - INSTA	1	06	MINOR	A	1166	1589	423.00	85
330-8097	330	@FTC40	CONNECT I-158 TO I-224 WIT	1	06	MINOR	A	245	205	-40.00	46
234-6124	234	@FTC02	B 234 - INSTALL WARNING L!	2	06	MINOR	A	1066	1401	341.00	548
234-8027	234	@FTC46	INSTALL 350 YD COAXIAL CAB	2	06	COMPLETE	A	1431	1103	-328.00	63
234-6125	234	@FTC08	INSTALL THREE EMERGENCY CU	3	06	MINOR	A	953	1088	135.00	573
235-7121	235	@FTC25	INSTALL CONDUIT FROM MPTV	3	06	MINOR	A	482	349	-133.00	312
235-8058	235	@FTC44	RESTROOM 105 - DIVIDE FOR M	3	06	COMPLETE	A	330	199	-131.00	53
MISC711:	336	@FTC07	INST 5 SMOKE DETECTORS W/S	3	06	MINOR	A	1624	1033	-591.00	284
427-7000	427	@FTC26	BLDG 427 - INSTALL PERSONN	3	06	MINOR	A	330	301	-29.00	354
428-8003	428	@FTC36	INSTALL METAL SHED NEXT TO	3	06	MINOR	A	1987	2005	18.00	48

Figure 3-5 Total Costs and the Variances of Total Costs Sorted by Maintenance and Repair

PM NUMBER	FACILITY NUMBER	JOB ORDER NUMBER	JOB DESCRIPTION 26 CHARS	2ND OPER FIELD	WC CODE	MATERIAL COST	LABOR COST	EST HOURS LABOR	DATE COMP REQUIRED
236-8003 MS UT ST		9229AA	PURCHASE CHEMICALS FOR BOI M		108C	768C	0	0	880107
WCC NUMBER 108C WCC NUMBER			TALLY:			1			
WCC NUMBER 108C MATERIAL COST			TOTAL:			768C			
WCC NUMBER 108C LABOR COST			TOTAL:			C			
WCC NUMBER 108C EST HOURS LABOR			TOTAL:			0			
220-7471	220	9119AA	MFG & INSTALL SIGNS FOR ME	M	10M	48	93	7	870913
220-7507	220	9170AA	VENTILATION OF OFFICE SPACE	M	10M	25	423	32	87:23:
220-8346	220	9162AA	REPAIR TWO LARGE CONDENSAT	M	10M	3662	425	32	880721
233-8046	233	9212AA	INSTALL HEATING SYST RM 20	M	10M	0	158	12	881126
234-7075	234	9216AA	INSTALL EXHAUST FAN APPROX	M	10M	2345	425	32	880827
234-8057	234	9271AA	OVERHAUL/REPLACE STORM PUM	M	10M	300	436	33	881014
236-9000	236	9287AA	BOILER HOUSE-PURCHASE & IN	M	10M	1892	292	22	881221
236-9001	236	9291AA	BOILER HOUSE- REPLACE INOP	M	10M	787	106	8	890106
258-8005	258	9274AA	INSTALL AIR COMPRESSOR SYS	M	10M	1215	79	6	881014
260-8001	260	9155AA	REMODEL WALK-IN FREEZER AR	M	10M	3162	1484	112	880104
330-8048	330	9152AA	REQUES" J.O. FOR MC-10 TO I	M	10M	194	364	28	881202
FNOC8089	702	9900AA	PURCHASE 20 HEATING CONTROL	M	10M	0	0	0	880107
MISC7240 MISC FAC:		9073AA	ANNUAL JOB ORDER FOR CORRE	M	10M	15	132	12	880930
MISC8112 AA UT WAT		9101AA	PURCHASE FRANKLIN MOTOR FO	M	10M	1200	0	0	880917
WCC NUMBER 10M WCC NUMBER			TALLY:			14			
WCC NUMBER 10M MATERIAL COST			TOTAL:			14886			
WCC NUMBER 10M LABOR COST			TOTAL:			4439			
WCC NUMBER 10M EST HOURS LABOR			TOTAL:			335			

Figure 3-6 Backlog of Work Requests Broken Down by Work Centers with a Delay Code of Material for All Work in the System

PM NUMBER	FACILITY NUMBER	JOB ORDER NUMBER	JOB DESCRIPTION 26 CHARS		2ND OPEN FIELD	WC CODE	MATERIAL COST	LABOR COST	EST HOURS LABOR	DATE COMP REQUIRED
221-7050	221	9139AA	ANNUAL INSPECTION 87		L	10M	0	106	6	880311
WCC NUMBER 10M	WCC NUMBER			TALLY:			1			
WCC NUMBER 10M	MATERIAL COST			TOTAL:			0			
WCC NUMBER 10M	LABOR COST			TOTAL:			106			
WCC NUMBER 10M	EST HOURS LABOR			TOTAL:			6			
236-8002	236	9147AA	PURCHASE AND INSTALL LARGE		L	1080	0	30	2	880620
WCC NUMBER 1080	WCC NUMBER			TALLY:			1			
WCC NUMBER 1080	MATERIAL COST			TOTAL:			0			
WCC NUMBER 1080	LABOR COST			TOTAL:			30			
WCC NUMBER 1080	EST LABOR HRS			TOTAL:			2			
221-7050	221	9139AA	ANNUAL INSPECTION 87		L	10M	0	106	6	880311
236-7013	236	9138AA	JO FOR WC1C TO INST 3 AUTO		L	10M	2950	212	16	880306
305-7007	305	9230AA	ANNUAL INSPECTION 86		L	10M	0	0	0	870728
ELECBOOK	222	9100AA	JOB ORD WC2C.10: INSTALL C		L	10M	0	79	6	880829
FNDC7052	700	9944A4	ROOM 185, REPLACE EXISTING		L	10M	250	320	21	870105
GC-7013 AR UT WAT		9112AA	REPLACE 30.F COURSE IRRIGA		L	10M	0	106	6	870513
PSU67005 PT ST GEN		9AA7.4	PT SUR HOUSING - CLEAN WAT		L	10M	0	0	0	880522
WCC NUMBER 10M	WCC NUMBER			TALLY:			4			
WCC NUMBER 10M	MATERIAL COST			TOTAL:			3050			
WCC NUMBER 10M	LABOR COST			TOTAL:			826			
WCC NUMBER 10M	EST LABOR HRS			TOTAL:			58			

Figure 3-7 Backlog of Work Requests Broken Down by **Work Centers with a Delay Code of Labor** for All Work in the System

identified and are helpful for monthly or end of year summary reports.

The backlog reports were designed to support lower to mid level management, specifically the shop supervisors and project schedulers. The backlog reports provide a snap shot in time by identifying projects tasked to the shops. These reports specifically address minor and specific jobs awaiting labor (by trade) and/or material. Backlog reports provide an identification of trades and resources required in order to complete work currently tasked to the production departments, see Figures 3-8 to 3-11, and Table 3-5.

It should be noted that these backlog reports do not address standing jobs, emergency service type work, or jobs currently in planning and engineering. These backlog reports specifically deal with minor and specific work categories only. Therefore, to gain a true measure of total labor resources required for production, one would have to add all categories of work by trade requirements. For example, Total Labor Requirements for production equals manpower for, Standing Work Orders + Minor Work Orders + Specific Work Orders + Emergency Work Orders + Service Chits. The difference of labor resources required less labor resources available identifies deficient or excess labor resources in a particular skill, trade, or work center. Such information is helpful in balancing labor, it identifies and justifies types of positions, trades, and

CURRENT NUMBER OF MINOR WORK REQUESTS BACKLOG	AS OF 19 JANUARY 1989 NPS PWD TRADE AND CODE	% OF TOTAL JOBS	TOTAL LABOR HOURS	CURRENT NUMBER OF SPECIFIC WORK REQUESTS BACKLOG
20—15—10—5—1				1—5—10—15—20—25—30—35—40—45—50—55—60
	AUDIO/VISUAL 10-AV	0.25	8	*
	BOILER OPS 10-B	0.50	2	**
	MAINTENANCE MECH 10-M	5.26	193	**********
	EMERGENCY 11	1.00	45	*****
*	LOCKSMITH 11-L	3.76	398	**********
****	MOVERS 11-M	1.75	66	***
**********	CARPENTERS 20-C	17.79	1,381	**********
******	ELECTRICIANS 20-E	16.29	2,504	**********
*****	PLUMBERS 20-PL	13.78	1,043	**********
*********	PAINTERS 20-PT	14.04	1,575	**********
****	WELDERS 20-W	3.76	456	**********
*	GARDENERS 32-G	1.50	33	*****
*****	LABORERS 32-L	8.02	594	**********
*****	TRANSPORTATION 34-T	12.53	1,601	**********
*	SHOP SUPERVISION 45	1.00	2	***
			10,181	

TOTAL 52 MINOR WORK REQUESTS IN BACKLOG

TOTAL 347 SPECIFIC WORK REQUESTS IN BACKLOG

Figure 3-8 Number of Minor and Specific Work Backlog by Trades as of 19 January 1989

LABOR COST OF MINOR WORK REQUESTS BACKLOG ($ 00)	AS OF 19 JANUARY 1989 NPS PWD	% OF TOTAL JOBS	TOTAL LABOR COST	LABOR COST OF SPECIFIC WORK REQUESTS BACKLOG ($ 000)
20---15---10---5---1	TRADE AND CODE			1---5---10---15---20---25---30---35---40---45---50
	AUDIO/VISUAL 10-AV	0.08	106	< $1,000
	BOILER OPS 10-B	0.02	30	< $1,000
	MAINTENANCE MECH 10-M	3.95	5,265	*****
	EMERGENCY 11	0.48	660	< $1,000
**	LOCKSMITH 11-L	3.71	5,078	*****
***	MOVERS 11-M	0.43	585	< $1,000
************************	CARPENTERS 20-C	13.76	18,835	******************
**********	ELECTRICIANS 20-E	26.02	36,224	**********************************
******	PLUMBERS 20-PL	10.59	14,496	**************
********************	PAINTERS 20-PT	15.33	21,315	********************
**********	WELDERS 20-W	4.66	6,376	*****
*	GARDENERS 32-G	0.28	386	< $1,000
****	LABORERS 32-L	3.70	5,067	*****
**********	TRANSPORTATION 34-T	15.68	21,477	********************
*	SHOP SUPERVISION 45	0.02	30	< $1,000
			136,330	

COST OF LABOR FOR MINOR WORK IN BACKLOG IS $ 9052

COST OF LABOR FOR SPECIFIC WORK IN BACKLOG IS $127,878

Figure 3-9 Estimated Labor Costs for Minor and Specific Work in Backlog as of 19 January 1989

MATERIAL COST OF MINOR WORK REQUESTS BACKLOG ($ 00)	AS OF 19 JANUARY 1989 NPS DOD	% OF TOTAL JOBS	TOTAL MATERIAL COST	MATERIAL COST OF SPECIFIC WORK REQUESTS BACKLOG ($ 000)
30---25---20---15---10---5---1	TRADE AND CODE			1---5---10---15---20---25---30---35---40---45---50
	AUDIO/VISUAL 10-AV	0.08	0	.
	BOILER OPS 10-B	5.65	7,680	********
	MAINTENANCE MECH 10-M	13.18	17,935	********************
	EMERGENCY 11	0.10	140	< $1,000
**	LOCKSMITH 11-L	1.19	1,624	**
	MOVERS 11-M	0.00	0	.
**********	CARPENTERS 20-C	12.22	16,622	**************
**********	ELECTRICIANS 20-E	16.77	22,812	*********************
**********	PLUMBERS 20-PL	14.71	20,013	********************
******	PAINTERS 20-PT	13.04	17,740	******************
*****	WELDERS 20-W	8.25	11,224	**********
	GARDENERS 32-G	0.02	24	< $1,000
	LABORERS 32-L	0.00	0	.
*	TRANSPORTATION 34-T	6.94	9,440	*********
**	SHOP SUPERVISION 45	7.92	10,777	**********
			$136,031	

COST OF MATERIAL FOR MINOR WORK IN BACKLOG IS $ 9,354

COST OF MATERIAL FOR SPECIFIC WORK IN BACKLOG IS $126,677

Figure 3-10 Estimated Material Costs for Minor and Specific Work in Backlog as of 19 January 1989

TOTAL COST OF MINOR WORK REQUESTS BACKLOG ($ 000)	AS OF 19 JANUARY 1989 NPS PWD	% OF TOTAL JOBS	TOTAL COST	TOTAL COST OF SPECIFIC WORK REQUESTS BACKLOG ($ 000)
20---15---10---5---1	TRADE AND CODE			1---5---10---15---20---25---30---35---40---45---50---55
	AUDIO/VISUAL 10-AV	0.04	106	< $1,000
	BOILER OPS 10-B	2.82	7,710	••••••••
	MAINTENANCE MECH 10-M	8.50	23,200	••••••••••••••••••••••••
	EMERGENCY 11	0.29	800	< $1,000
< $1,000	LOCKSMITH 11-L	2.46	6,702	•••••••
< $1,000	MOVERS 11-M	0.21	585	< $1,000
*****	CARPENTERS 20-C	12.99	35,457	•••••••••••••••••••••••••••••••
*****	ELECTRICIANS 20-E	21.81	59,536	••
***	PLUMBERS 20-PL	12.64	34,509	••••••••••••••••••••••••••••••••
***	PAINTERS 20-PT	14.49	39,555	••••••••••••••••••••••••••••••••••••
**	WELDERS 20-W	6.45	17,600	•••••••••••••••
< $1,000	GARDENERS 32-G	0.15	418	< $1,000
< $1,000	LABORERS 32-L	1.86	5,067	•••••
*	TRANSPORTATION 34-T	11.33	30,917	•••••••••••••••••••••••••••••••
< $1,000	SHOP SUPERVISION 45	3.96	10,807	••••••••••••
			$272,369	(LABOR AND MATERIAL)

TOTAL COST OF MINOR WORK IN BACKLOG IS $ 18,406

TOTAL COST OF SPECIFIC WORK IN BACKLOG IS $254,563

Figure 3-11 Estimated Total Costs for Minor and Specific Work in Backlog as of 19 January 1989

TABLE 3-5

BACKLOG MANAGEMENT BY TRADE FOR MINOR AND SPECIFIC WORK ORDERS

TRADE DESCRIPTION	10-AV	10-B	10-H	11	11-L	11-M	20-C	20-E	20-PL	20-PT	20-W	32-G	32-L	34-T	45	TOTALS
MINOR WORK ORDERS																
TOTAL NO. OF JOBS	0	0	0	0	1	4	11	6	5	9	4	1	5	5	1	52
ESTIMATED MAT'L COSTS ($)	0	0	0	0	192	0	2,627	3,409	1,045	601	480	0	0	50	150	9,554
ESTIMATED LABOR COSTS ($)	0	0	0	0	202	345	2,324	1,103	607	1,813	1,123	92	412	997	30	9,052
ESTIMATED LABOR HOURS	0	0	0	0	16	42	180	88	48	140	88	8	51	82	2	748
ESTIMATED TOTAL COSTS ($)	0	0	0	0	394	345	4,951	4,512	2,452	2,414	1,603	92	412	1,047	180	18,606
SPECIFIC JOB ORDERS																
TOTAL NO. OF JOBS	1	2	21	5	14	3	60	99	38	47	11	5	27	40	2	347
ESTIMATED MAT'L COSTS ($)	0	7,680	17,935	140	1,432	0	13,995	19,603	10,160	17,139	10,774	24	0	9,390	10,627	126,677
ESTIMATED LABOR COSTS ($)	106	30	5,265	660	4,876	236	16,511	35,621	13,889	20,002	5,253	774	4,655	20,480	0	127,878
ESTIMATED LABOR HOURS	8	2	753	45	382	24	1,201	2,496	995	1,431	368	28	343	1,519	0	9,432
ESTIMATED TOTAL COSTS ($)	106	7,710	23,200	800	6,308	236	30,506	55,024	32,057	37,141	15,957	318	4,655	29,870	10,627	254,555
TOTAL WORK ORDERS																
TOTAL NO. OF JOBS	1	2	21	5	15	7	71	65	95	56	15	6	32	45	3	399
ESTIMATED MAT'L COSTS ($)	0	7,680	17,935	140	1,624	0	16,622	22,812	20,013	17,740	11,224	24	0	9,440	10,777	136,031
ESTIMATED LABOR COSTS ($)	106	30	5,265	660	5,078	581	18,835	36,724	14,496	21,815	6,376	806	5,069	21,477	30	136,930
ESTIMATED LABOR HOURS	8	2	753	45	398	66	1,381	2,584	1,043	1,571	456	35	394	1,601	2	10,177
ESTIMATED TOTAL COSTS ($)	106	7,710	23,200	800	6,702	581	35,457	59,536	34,509	39,555	17,600	410	5,069	30,917	10,807	272,961
% TOTAL NO. OF JOBS	0.25	0.50	5.26	1.25	3.76	1.75	17.79	16.29	13.78	14.04	3.76	1.50	8.02	11.28	0.75	100.00
% TOTAL EST. MAT'L COSTS	0.00	5.65	13.18	0.10	1.19	0.00	12.22	16.77	14.71	13.04	8.25	0.02	0.00	6.94	7.92	100.00
% TOTAL EST. LABOR COSTS	0.08	0.02	3.85	0.46	3.71	0.43	13.76	26.82	10.59	15.93	4.66	0.28	3.70	15.68	0.02	100.00
% TOTAL LABOR HOURS	0.08	0.02	3.84	0.44	3.91	0.65	13.57	25.39	10.25	15.44	4.48	0.35	3.84	15.73	0.02	100.00
% EST. TOTAL COSTS	0.04	2.82	8.50	0.29	2.46	0.21	12.99	21.81	12.64	14.49	6.45	0.15	1.86	11.33	3.96	100.00

BACKLOG PRIORITY BASED ON NUMBER OF JOBS IN SYSTEM	BACKLOG PRIORITY BASED ON MATERIAL PROCUREMENT	BACKLOG PRIORITY BASED ON ESTIMATED LABOR HOUR AMOUNT	BACKLOG PRIORITY BASED ON TOTAL COST
20-C CARPENTER	20-E	20-E	20-E
20-E ELECTRICIAN	20-PL	20-PT	20-PT
20-PT PAINTER	10-H	34-T	20-C
20-PL PLUMBER	20-PT	20-C	20-PL
34-T TRANSPORTATION	20-T	20-PL	34-T
32-L LABORER	20-W	20-W	10-H
10-H MAINT. MECH.	45	10-H	20-W
20-W WELDERS	34-T	11-L	45
11-L LOCKSMITH	10-B	32-L	10-B
11-M MOVERS	11-L	11	11-L
32-G GARDENERS	11	11-M	32-L
11 ENGINEERING	32-G	32-G	11
45 SHOP SUPERVISION		10-AV	11-M
10-B BOILER		10-B	32-G
10-AV AUTO/VISUAL		45	10-AV

skills necessary to support the mission of a PWD. In addition, proper recruitment, hiring and training practices of labor resources identified through backlog helps to improve work force efficiency, production, scheduling, and keeps pace with changing requirements.

The following trade catagories and work centers were developed and used in the backlog reports to determining labor requirements for minor and specific work:

TRADE DESCRIPTION	WORK CENTER	TRADE CODE
Audio/Visual	WC-10	10-AV
Boiler Operator	WC-10	10-B
Maintenance Mechanic	WC-10	10-M
Emergency Crews	WC-11	11
Locksmith	WC-11	11-C
Movers	WC-11	11-M
Carpenters	WC-20	20-C
Electricians	WC-20	20-E
Plumbers	WC-20	20-PL
Painters	WC-20	20-PT
Welders	WC-20	20-W
Gardeners	WC-32	32-G
Laborers	WC-32	32-L
Transportation	WC-34	34-T
Shop Supervision	WC-45	45

Once labor resources available and backlog work by trade has been identified, the auditor and labor resource teams can provide documented evidence to support their recommendations to balance labor resources with work requirements. Recommendations may be temporary or permanent, however, it should be noted that such a method provides a dynamic monitoring system for labor resources (vice a static system) which is necessary to keep pace with changing and increasing requirements of a PWD.

IV. CASE STUDY

A. INTRODUCTION

The effective balance of labor resources must be approached in a systematic manner. Labor efficiency and proper mix of labor skills is a topic that is much broader than simply how much is paid in salary, wages, and benefits. In fact, it can be shown that labor efficiency and proper mix of skills is often directly related to a command's overall operational efficiency. For example, unskilled labor, improper labor mix and distribution, effectiveness of process, and production control practices influences product quality, increases labor usage, material costs, and contribute to unexpected or unscheduled rework.

This chapter is a summary of findings from a macro labor audit study conducted for the Public Works Department, Naval Postgraduate School, Monterey, California. The flow chart in Figure 4-1 illustrates steps taken by the author to develop and focus efforts of the investigation.

B. OBJECTIVE

The overall objective of such a study was to initiate, stimulate, and develop labor auditing thinking and practice in a small to medium sized Public Works Department. Specifically, this program was designed to implement a prototype labor auditing system for determining and

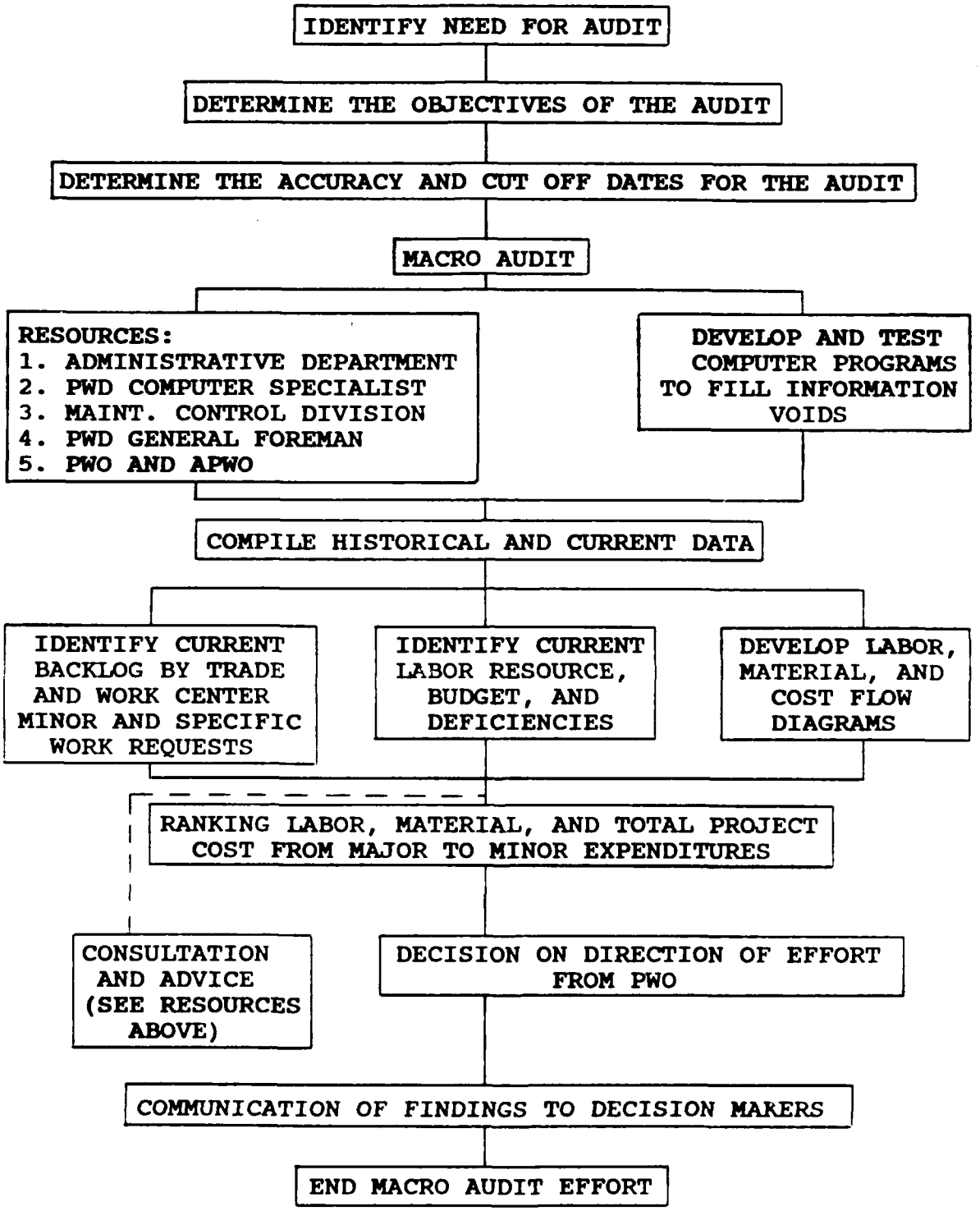


Figure 4-1 Flow Chart for Cast Study Macro Labor Audit

budgeting for proper level, mix, and balance of personnel, and address costs associated with labor to support maintenance and repair operations at the Naval Postgraduate School (NPS).

The above overall objective was achieved through the following sub-objectives and tasks:

- Close cooperation and collaboration between the Public Works Officer, Assistant Public Works Officer, Administrative Assistant, Planning and Estimating Division, Maintenance Control Division, Public Works General Foreman, and Public Works Computer Specialist had to be established.

- A seminar was held, with the support and cooperation of the PWO to which all participating cost centers were invited. This seminar was a one-day event in which project details were described and potential benefits to participants were outlined.

- After careful discussion and analysis of the labor audit proposal, a modified version was adapted. The modified version was designed to reduce the substantial burden to cost centers that required enormous time to gather or to generate specific reports and historical records to address issues. The modified version limited the labor audit to two areas of production, Specific Work Requests and Minor Work Requests. In addition, the PWO requested information that would identify current labor resources by skill or trade, identify requirements or needs for specific skills not currently on board, identify excess available labor, and identify the actual backlog of Specific and Minor Work Requests.

  To accomplish this task utilizing existing capabilities, the author of this thesis designed, developed, and tested computer programs external to the BEST system to assist in data collection (see page 52 for a list of programs). Data retrieved from the use of computer programs provided necessary information to complete the macro audit.

  After all computer programs were operational, it was agreed that the following cut off dates for data collection would be use for analysis:

a. 30 December 1988 for PWD Billet Listing.

b. 15 December 1988 for Maintenance and Repair Total Project Cost Variance, Material Variance, Labor Hour Variance, Labor Cost Variance, and Length of Time a work request has been in the system before completion.

c. 19 January 1989 for Backlog of Work Requests broken down by work centers with a delay code of materials (awaiting materials) and Backlog of Work Requests broken down by work centers with a delay code of labor (awaiting labor).

- While cost centers were addressing specific questions, the author was available to consult with the cost center's personnel and to assist them in data collection and preparation, and at the same time, develop a detailed list of potential problems.

- Following the submission of completed information by a cost center, data were extracted and analyzed using analytical and graphical techniques. At the same time problems associated with a specific work center's data were identified and analyzed.

- Brief meetings were held weekly with each participating cost center to identifying problem areas that were discovered within that cost center. During these meetings it was important to keep in perspective and stress the four basics of a labor audit management program:

a. Identify
b. Quantify
c. Modify
d. Verify

Executive level (macro audit)

Middle management (micro audit)

It became important to emphasize that the macro audit will accomplish only the first two of the four basic requirements. During the macro audit, labor needs were identified and tied to mission requirements to determine if there were a potential for savings or if further expenditures would be necessary to acquire deficient

resources and to identify what alternatives exist. Modification and verification will not take place until after the macro audit is performed and reviewed by both the audit team and management.

C. ACCURACY OF THE MACRO AUDIT

The macro audit involved a general evaluation of information readily available at the PWD. Detailed analysis was left to department personnel, while broad analyses and interpretations were made by the author. In particular, the author assisted PW management in understanding the overall labor audit process and in suggesting areas worthy of concentrated effort. Figures and tables presented throughout this study are compiled from actual data and were effective for the purposes of illustration, training, and informing management, which provided for a more informed and educated decision process relating to labor and budget resources. However, improvements and changes could and should be made to satisfy personal preference or to present these facts more adequately to a decision maker or to higher authority.

D. MACRO AUDIT DISCUSSION OF FINDINGS

The ultimate purpose of the macro audit is to provide a workload management and planning basis for labor resource management and planning. Three primary resources required by an activity are manpower, facilities, and funding. Of

these, manpower (labor) is considered the most significant since it is labor which constitutes a work force through which effort is applied for the accomplishment of the workload. The facilities represent tools required by the work force to accomplish work, and funding is required to keep the work force employed. Consequently, the primary concern is to convert workload (backlog) into manpower requirements.

The difficulties involved in converting workload to labor requirements at any activity can be further complicated by the "three-dimensional" nature of the work force: civil service, military, and contractor. Each component of the total labor work force is governed by a unique set of regulations, restrictions, and funding procedures; however, they all play important roles in the overall accomplishment of the activity's total workload. Consequently, the problem evolves into one of determining, not only the overall labor requirements, but the optimum mix of civil service, military, and contractor manpower.

After the projected workload (backlog identification by trade) has been determined, the problem then becomes one of formulating a viable work force plan based on current and projected workload. The process, as depicted in Figure 4-2, is an iterative one of matching the available "three-dimensional" labor resources with requirements dictated by projected and current workload.

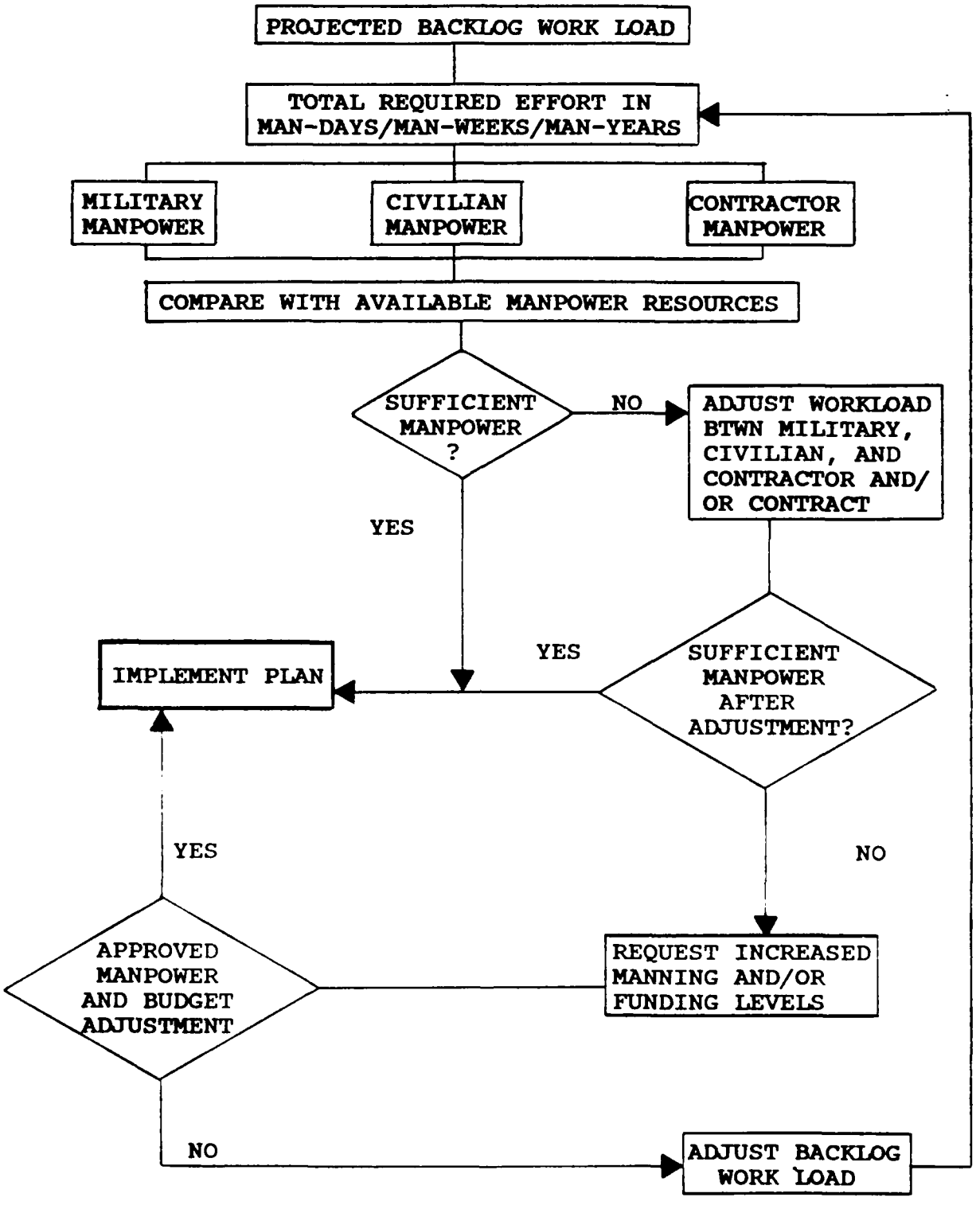


Figure 4-2 Flow Diagram for Converting Backlog to Labor Force Planning

Projected workload must first be converted to required civil service, military, and contractor labor resources. These are then compared with available labor resources. If available labor, in either of the components, is not sufficient, an attempt should be made to adjust work between the three components, contracting out more of the direct workload if feasible. If shortages still exist, requests for increased civil service ceilings and/or military manning levels should be made. If this is unsuccessful, an adjustment must be made to the planned workload; for example, management must decide which projects will not be accomplished. The comparison-adjustment process is an iterative one, and should continue until a match between requirements and availability is achieved. It should be noted that, for the process to be an orderly one, the analysis must be made far enough in advance to allow for appropriate actions to be taken systematically in accordance with the PPBS process.

1. Finding the Budget Base for NPS's PWD

One of the most difficult problems NPS faces is the maintenance of consistent, adequate funding levels in Maintenance and Repair of Real Property (MRRP). Based on historic documentation and recent track record, MRRP is apparently regarded in Washington as a basket for stashing or retrieving large amounts of money at will--without consideration of the impact this has on maintenance or

material condition of Navy property. In Fiscal Year 1986 (FY-86) for example, NPS was faced with a 50% reduction in MRRP for FY-88. Of course, this had no impact on then-year execution or planning. However, it required extraordinary amounts of time and effort for the school to highlight the reduction and then to achieve restoral through re-justification of need. In FY-87, a similar reduction in Special Project funding was proposed then dropped after the school noted that Military Construction (MILCON) funding had been absent for 20 years, and that NPS depended on such funds for lab improvements in progress.

The tactic seems to be to probe for weak areas in the budget by suggesting cuts and then requiring the activity to re-justify its base. The level of effort required to reinvent the wheel severely detracts from other efforts to obtain maximum productivity for the dollar. This tactic obscures the real base budget, making it easier to add additional tasking later on without providing commensurate resources. Over the past two years, NPS has been bombarded with requests for impact statements for proposed reductions, including MRRP funding, by analysts who have neither an appreciation for the program being supported nor are they held accountable for the results of their action. One solution the Navy could make is to decide upon a base level of MRRP funding and then support it for the long haul.

In 1984, the PWD of the NPS "won" the contract to perform maintenance as a result of the Commercial Activity study (CA) begun in 1982. The PWD was the low bidder on the contract calling for the performance in FY-88 of 135,000 manhours of labor at a cost of $2,838,000. Since that time, the scope of work has increased by an estimated 14,000 manhours (approximately 10%), and the level of funding has dropped by $273,000 (approximately 10%) in labor from that agreed to in the original contract.

PUBLIC WORKS "CONTRACT"

FY-88 Winning Bid		FY-88 Actual
134,574	MANHOURS	130,000
$2,838,000*	COST	$2,565,900

*Adjusted from $2,789,000 for pay raises since 1984.

It is extremely doubtful that a civilian contract "winner" would tolerate similar treatment without resorting to the courts. Increases in the scope of work or Navy-induced delays in contract completion would have had expensive consequences.

In 1986, NPS commenced Managing to Payroll (MTP). This scheme requires, at the outset, that an accurate pricing of the civilian work-force be made so that payroll costs can be controlled and managed. NPS and OPNAV did not agree on what the payroll costs were initially, and the school has

labored under this shortcoming ever since. The OPNAV solution seems to have been to "cut the coat to fit the cloth." As expected, this approach results in leaving NPS with insufficient resources. For example, this cloth-cutting resulted in the loss of 31 end strength school-wide for FY-89. The Base Operations share of this cut is six MRRP end strength and four end strength in Base Operating Support (two in transportation, two in Administration). This is a $250,000 shortfall this year. It should be noted, six of these are the same MRRP billets identified in the 1984 CA study (which required PW to reduce to a "most efficient organization") that now cannot be supported. In addition, there is also a $95,000 shortfall in Engineering Support labor caused by the same MTP problem. The school has covered this shortfall through OPTAR transfers and lapses, but these practices further degrade the support that could otherwise be provided.

NPS is also threatened with a 22 man-year reduction, which, if implemented, would cause an additional reduction of ten people in Base Operations (two in Supply, one in Security, two in MRRP, three in Administration, and two in Engineering Support). For the support side of the house, this translates to a loss of $251,000 in payroll and benefits. Unofficially, the school has been told that this man-year reduction will be restored if they can justify why the money is needed. In other words, NPS must re-justify

the base again. This is contrary to the conclusions of at least two recent reports, the NPS Naval Audit Service Report [Ref. 5] and the Naval Inspector General Report [Ref. 6]. Both reports clearly identified many issues that need to be resolved; however, they fail to address additional manpower and funding requirements necessary to implement recommendations to be in compliance with findings.

In summary, if both of the above reductions occur, the base operations portion of NPS would need $606,000 in labor dollars simply to regain the budget base it had in FY-86. This amount only allows the school to tread water and does not redress the long-standing maintenance and repair deficiencies rampant around the campus.

2. Standing Job Orders

Current manning levels in the PW shops were established in 1984 as a result of the CA study. One of the assumptions used was that the student population would be about 1,200. A 1983 space study documented that the campus could adequately handle this population. The on-board count now is 1,600 students (the programmed population is 2,000 students). To support the student increase, there was also a similar increase in faculty. More importantly, since 1984, there have been various laboratory initiatives which have installed $11,000,000 in equipment and caused the construction of $2,000,000 in real property systems to support these improvements. The backlog of standing

maintenance jobs in an aging facility such as NPS is normally high. However, at NPS it is being added to at a rapid pace. To properly address this problem, additional permanent manning is required as shown below:

POSITION	GRADE	NUMBER	COST
Maintenance Mechanic	WG-9	5	$128,000
Maintenance Mechanic	WG-8	1	$ 24,397
		Total	$152,537

3. Specific and Minor Work

Currently, the backlog in specific and minor work is approximately 14,000 manhours and represents over 1,000 work requests. The Annual Inspection Summary (AIS) is about 3,500 manhours. The number of priority one jobs awaiting accomplishment exceeds 350, with over two-thirds of these being past their estimated completion dates (overdue). Over the past two years, the amount of time for the average work request to proceed through the system has grown from four to over 11 months. This backlog is due to an increase in the number of students, research projects, office moves to accommodate academic department growth (faculty and labs) and inadequate manning levels. To reduce this backlog to manageable levels, additional permanent or temporary manning is needed as shown:

Position	Grade	Number	Cost
Electrician	WG-8	2	$ 48,794
Electrician	WG-10	3	$ 80,454
Carpenter	WG-9	2	$ 51,256
Maintenance Mechanic	WG-10	1	$ 26,818
Plumber	WG-9	2	$ 51,256
		Total	$258,587

4. Procurement of Material

To properly acquire the material needed to meet daily requirements and to expedite repairs in progress, additional manpower is needed to improve material estimating and scheduling. Through the use of the existing Officer In Charge of Construction (OICC) contracting warrant to establish construction material contracts through base procurement authority, a simple method can be devised to expedite material procurement without violating procurement rules and regulations. The advantage to PW is faster procurement and increased efficiency of the organization. A side benefit of this initiative is that it would also reduce Supply Department procurement backlog. The minimum permanent manning for this change is:

Position	Grade	Number	Cost
Buyer	GS-7	1	$ 22,093
Procurement Clerk	GS-7	1	$ 22,093
Production Controller	GS-7	1	$ 22,093
		Total	$ 66,279

5. Support Contracts Performance

The administration of facility support contracts is an NPS responsibility which has been ignored for too long. The number of Quality Assurance Evaluators (QAE) is insufficient to ensure that each contract is fully executed and that the government receives all that it is entitled to. The effort to update contract specifications and ensure the continuity of service required by these contracts requires a full-time organization devoted to this purpose. The function can no longer be performed ad-hoc and out-of-hide. This function was not part of the CA study in 1984, yet is a requirement if the Navy is to avoid waste. The following permanent positions are recommended:

POSITION	GRADE	NUMBER	COST
QAE	GS-5	1	$ 17,838
QAE	GS-7	1	$ 22,093
Specification Writer	GS-7	1	$ 22,093
		Total	$ 62,024

6. Design Staff

Recently, NPS has been successful in developing and gaining support for a number of MILCON projects. Currently, there is one project underway and ten projects under design. The effort to properly design and coordinate these projects is proving immense and is now using all available engineering support resources. The effort is conflicting with the assignment of station and special projects which are also important. The engineering support staff needs to be augmented to handle this additional work and allow simultaneous proper execution of MILCON, Special Project, and Station workloads. It is envisioned that augmentation would be temporarily needed for the next three years only, until the "bow wave" of MILCON is under control.

Position	Grade	Number	Cost
Engineer	GS-11	2	$ 72,884
		Total	$ 72,884

7. Cost Summary

The following is a cost summary of the preceding labor initiatives. An additional OPTAR augmentation of $275,000 is shown to provide funding of materials purchased for this additional work force.

Function/Area	Cost
Labor Restorals	$ 606,000
Standing Job Orders Labor	$ 152,537
Specific and Minor Work Labor	$ 258,587
Material Procurement Labor	$ 66,279
Support Contracts Labor	$ 62,024
MILCON Design Labor	$ 72,884
Total	$1,281,311
OPTAR Augment (material)	$ 275,000
Grand Total	$1,493,311

E. OVERALL INFRASTRUCTURE

As noted earlier, NPS is only beginning to recover from a 20 year MILCON drought. Execution of the current programmed MILCON projects through 1992 would go a long way toward rectifying those years of neglect. Through excellent coordination with OPNAV, NPS has made excellent use of Special Project funding to sustain itself in the absence of MILCON. NPS has positioned itself to take advantage of any year-end budget windfalls by being in a posture to immediately execute a number of projects. Hopefully, the excellent support the school has received from OPNAV in Special Projects funding will continue to complement the current MILCON efforts. The $3,000,000 per year in Special Project funding received in recent years has done much to rejuvenate an aging physical plant, improve laboratory

facilities to keep pace with technology, and to create the space for an expanding faculty and student population.

However, in the nature of things, virtually nothing man-made is indestructible, but the useful life can be extended by carrying out proper maintenance and repairs. This may appear to be stating the obvious, and it is precisely because this function of carrying out maintenance and repairs has been taken for granted over the years, without much thought being given to its importance in the day-to-day business of an activity or, in other terms, the labor resources, cost, and effort involved to maintain the complex and costly assets of the Navy.

For a PW activity to provide continued acceptable levels for planning, scheduling, and execution of work will require the Navy's decision and commitment for: minimum levels of MRRP funding per activity; minimum labor resources to provide "acceptable" levels of maintenance and repairs at each activity; and to commit and support funding levels for the long haul. MRRP funding levels should only be adjusted up or down to support increases or decreases in mission tasking, not by arbitrary across-the-board funding cuts.

V. CONCLUSIONS AND RECOMMENDATIONS

In order for a labor resource audit to be meaningful, a feedback system must be devised through which controls may be provided to ensure accomplishment of the planned workload. It appears that not enough emphasis is currently placed on the feedback and control aspects at the Navy PWDs. As noted earlier, integration of the labor resource audit with the financial system currently being developed (RE-WRITE DATABASE SYSTEM), would provide the necessary feedback and facilitate the required control of workload planning. A planning and control model, showing the necessary feedback loops, is presented in Figure 5-1. As shown in the model, planning and control, when properly conducted, is a never-ending, continuous process.

The planning process may be thought of as consisting of four identifiable steps:

- Determine, as accurately as possible, the nature of the future environment in which the plan is to be executed.
- Establish goals and objectives for the organization within the given projected environment.
- Establish plans and procedures to meet the established goals and objectives.
- Implement the established plans and procedures.

In the process of forecasting the future environment, it is necessary to make assumptions concerning such items as future evaluation requirements, the nature of new

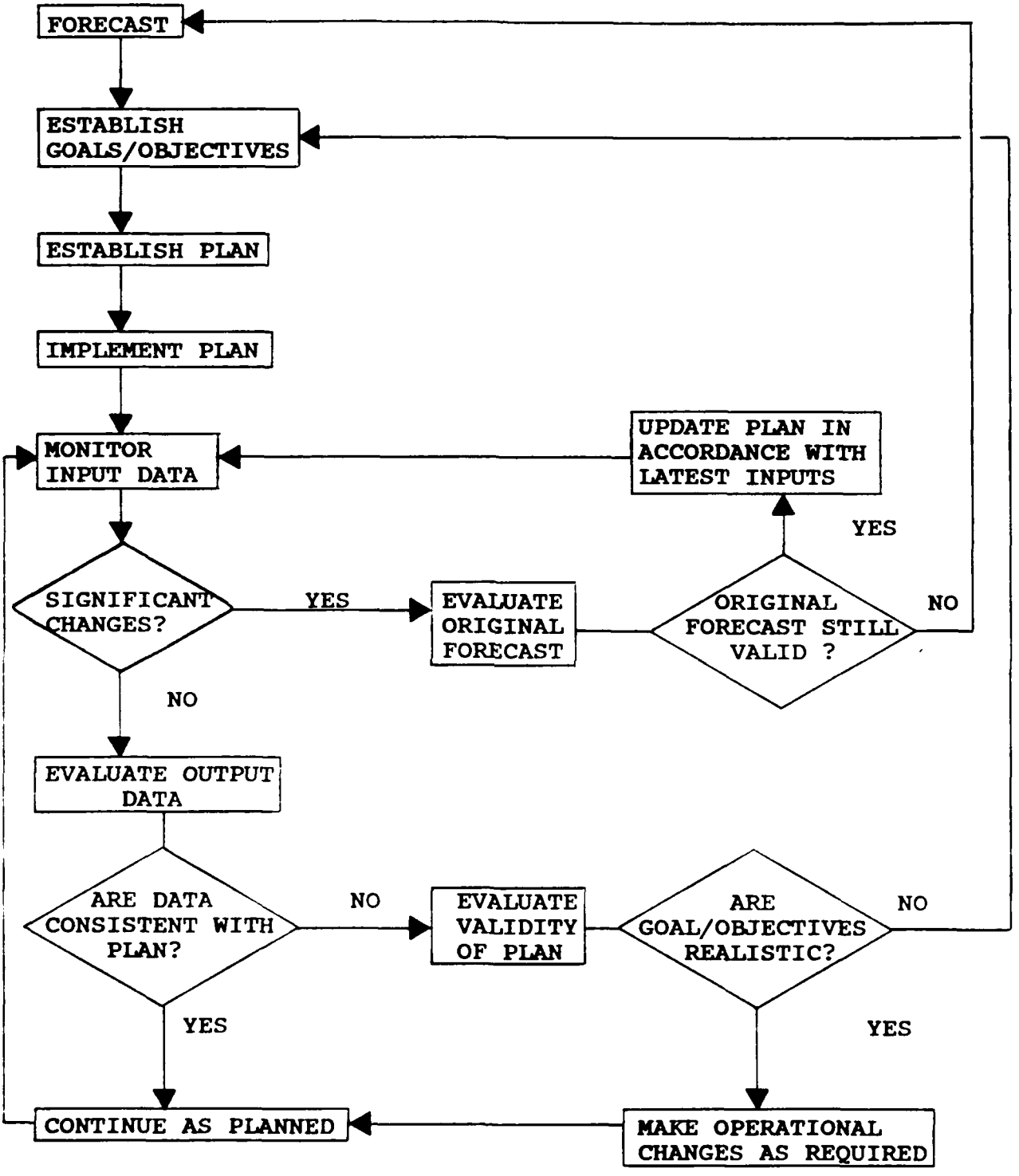


Figure 5-1 Planning and Control Model for a Labor Resource Audit

technology, economic conditions, availability of resources, etc. These inputs must be documented explicitly in quantitative terms. If possible, the expected accuracy and reliability of each of the projections should be documented. These predictions form the framework within which the goals and objectives of the department are formulated. It is now a matter of delineating specific plans and operating procedures, and establishing milestones, for achieving the goals and objectives of the department, and exploiting, to the department's benefit, the assets which may be available in the projected environment.

After the plan has been implemented, it must be continually re-evaluated, updated and/or revised, consistent with the latest information available to management. Implicit in the entire process is a continual monitoring of the assumptions and the forecasts concerning the environment during the planning period.

A. TRANSFERABILITY OF RESULTS

Specific formats, in terms of organizational structure, number of personnel in a work center, cost per unit, units produced, or time to produce are not meant to be transferable to other PW activities. In fact, no attempt should be made to use them without some type of validation. Some factors which can influence the labor audit applicability include: type of command, quality of historical documentation available, economic profile of the

activity, physical characteristics of the plant, availability of staff, policy issues, and quality of the work force. Labor auditing standards are, however, a baseline; and the procedures used to develop them are basically adaptable to any activity and any function.

Other outcomes, however, are directly transferable such as variances and back-log computer programs available in the appendix section of this thesis. These can be adapted to advantage in many, if not all, activities who have direct access to a BEST system. However, with or without the BEST system this procedure will provide a sound basis for:

- Determining whether to handle specific jobs on a contract basis or by the available maintenance work force.
- Shifting labor resources between crafts and jobs as the work load changes.
- Recommending a short/long-term increase or decrease in the total maintenance force size and structure.
- Planning when large projects can be started and completed.
- Controlling maintenance and repair overtime.
- Making sure that a full day's work will be available and scheduled for each labor resource.

B. LESSONS LEARNED AND REITERATION OF KEY POINTS

1. Department Involvement

In this project, all division directors within the Public Works Department were brought in at the beginning stages, their suggestions were solicited, and they were kept involved throughout. The labor resource audit process was

never presented as a threatening possibility, and it was never perceived as such.

2. Conducted Survey

A survey conducted by the author during the initial development effort, identified characteristics necessary to ensure support and acceptance for continued use as a management tool. The essential precepts are:

- All approved work is divided into logical, manageable elements.
- Once work has been divided, specific responsibility for accomplishment must be assigned.
- All approved work must be scheduled and budgeted so as to provide meaningful budget and schedule baselines for performance measurement.
- Effective integration of work scope, schedule, budget and organization.
- Cost and schedule performance must be analyzed three ways, as a comparison of work-planned versus work-accomplished, versus actual resources expended.
- Must provide for the disciplined control of budget, schedule and baseline changes and for the analysis of change impact.
- Must be capable of rapid processing and turnaround of information in the form of timely reports.
- Must provide the basis for continuously updated estimates of project manhours and cost.

3. Unmeasurable Areas

In many cases, areas considered to be "un-measurable" could be in fact measured. No function was prematurely dismissed as "un-measurable." Through the resource audit seven once "un-measurable" functions were addressed and resolved, providing nearly all the information

management needs to make informed decisions on labor and budget resources. These areas were:

- Personnel and manpower resources.
- Back-log identification by work center and trade.
- Equipment and materials.
- Schedules and planned operations.
- Physical progress: quantities in place and work remaining.
- Costs and manpower/resources expended and for what, including commitments, funding flow, and forecasts.
- Quality assurance in all maintenance and repair functions, procurement, and standing job order activities, keyed to management responsibilities at appropriate levels.

4. Department Participation

Each division director has, through participation in this project, demonstrated a willingness to be open, examined and compared; and where better procedures can be found, to use them. Just the willingness to have such an examination performed and to try to live with the results is an important first step. There may be valid reasons for "higher-costs" in operating a work center; simply knowing that a particular procedure is "higher-cost" cannot be taken at face value as condemnation. Determining that there are ways to change and selecting the best ones can only be done once the necessity for a change is established.

5. Labor Resource Audit

The labor resource audit provided informed decisions about timing, funding, methods, equipment, and personnel to

be used for each task of each activity of each mission requirement. What to make and what to buy? What to contract out and what to fabricate and do in-house? How to get resources to the job? How to coordinate their use?

The principal advantages division directors found in using the audit are: simple and quick evaluation of results; timely reporting progress; short and long-range planning capability to coordinate labor, material, and budget; coordination between current capabilities to work requirements; identification of duplicated and unnecessary services and/or services not being performed; and as a model for the department (or work center) to quickly investigate effects of various changes in plans, sequence, timing, budget, and personnel.

C. FINDINGS AND RECOMMENDATIONS

1. Finding #1

To fully utilize performance standards, variances, and historical documentation as a management tool requires information to be readily available, inexpensive to retrieve, presented in a useful format, and providing a high degree of creditability.

a. Finding

Should this site be representative of other BEST users it would be safe to assume that less than 20% of the data fields are maintained, and of that, very few if any, are complete or up-to-date.

b. Recommendation

Training should be provided to all division directors to explain and demonstrate the capabilities and identify the weaknesses of the BEST system. A complete evaluation should be undertaken to determine to what extent the system is utilized; how it is being used, for what purpose; and how effective it is in providing creditable information for management review. Computer capability and information should benefit the entire department, not the needs of a few individuals. At a minimum all data fields should be maintained and kept up-to-date and ownership and responsibility of the data base needs to be addressed.

2. Finding #2

The major purpose of variance analysis is to enable management to measure performance against predetermined norms, to seek out the causes for off-standard results, and to institute corrective action in a timely manner. However, before there can be a fair judgement concerning good or poor performance, the measure of acceptable performance, a standard, must be applied to actual results. Since a meaningful standard must bear the stamp of duly constituted authority, the standards used to measure performance must have been promulgated by management and recognized and accepted by those whose performance is being evaluated. A standard, therefore, is a measure of acceptable performance, established by management as a guide to certain economic

decisions. It is, in short, a reflection of what management thinks a cost ought to be, based on past experience.

a. Finding

Little to no effort is made to collect, identify, and analyze: time, material, labor, and total cost variances; therefore, no feed-back mechanism exists to identify potential problems and take corrective action in a timely and economical manner.

b. Recommendation

It is recommended that some type of on-line variance method, or an equivalent method of project cost control be implemented on every project. Progress, performance, or variance reports are important tools for PW to use in taking the necessary decisions and actions at the appropriate time to keep projects on schedule and within budget. Early definition of project scope and development of detailed work plans are of the utmost importance for the measurement of progress, productivity, and efficiency, and, hence, the success of the department.

3. Finding #3

To analyze backlog basically involves three steps which include calculation of work requirements in terms of man-hours of effort, calculation of current production capability in terms of man-hours per unit, and comparing production capability to production requirements to determine the proper balance and mix of personnel required.

The difference between labor resources required less labor resources available identifies deficient or excess labor resources for a particular skill or trade. This information is helpful for balancing labor, identifying and justifying types of positions, trades, and skills level necessary to support operations. Furthermore, proper recruitment, hiring and training practices of labor resources identified through this method helps improve work force efficiency, production, scheduling, and keeps pace with changing requirements.

a. Finding

Current procedures provide little insight for identifying or analyzing backlog, in-coming work requests, and labor requirements; therefore, decisions to determine type, skill level, and mix of personnel and/or hiring practices are not informed and lack creditability.

b. Recommendation

It is recommended that a labor resource audit be conducted at least twice a year (mid-year and before the budget call). This would provide upper level management a feed-back mechanism to plan more efficiently, identify potential problems, and take corrective action in a timely and economical manner. In addition, a labor resource audit should be conducted using backlog as an indicator to select appropriate trade, skill level, and mix of personnel prior to any hiring or a reduction in force efforts. Table 3-4

should be computerized in spread sheet form and kept up-to-date. Although not shown in the table a column could be added to include the individual name associated with the position. This would provide personnel and labor budget information in one source and provide insight to the "what if" type budget and labor questions.

D. SUMMARY

Five months have passed since labor auditing was introduced as a method for determining and budgeting for proper level, mix and balance of personnel to support maintenance and repair operations at a Public Works Department. Those five months have seen gradual but steady improvements at the Naval Postgraduate School's Public Works Department in performance, cost reduction, and general attitude of personnel. The labor resource audit, back-log identification, and on-line variance reports are seen as performance standards, a yard-stick by which to gauge accomplishments; productivity measures help evaluate progress.

On the management side, the labor resource audit enjoys quite a favorable reputation. Areas targeted as needing improvement have been addressed, with new procedures established and measurable gains experienced. Solid communications were established among managers, a previously untapped source of resolution of problems and origination of

ideas. They have noticed, and welcomed, improved communication with workers as well.

The workers have also felt the impact of the labor audit in a positive manner. Although it may sound trite, employees have seen evidence that managers care, are aware of some problems areas, are trying to make improvements, and are not averse to trying employee ideas and suggestions. Employees began to demonstrate a greater sense of pride in their work, once they realized someone was paying attention.

In the course of labor auditing the data created by the measurement and reporting systems are continually used to identify new areas of potential improvements for personnel, budgeting, scheduling, and project control to balance and properly mix available resources. Now that the basic approach and underlying concepts have become familiar, it is an ongoing continuing challenge to find more ways to improve efficiency and effectiveness.

APPENDIX A

VARIANCE REPORT ON LENGTH OF TIME A WORK REQUEST HAS BEEN IN THE SYSTEM BEFORE COMPLETION

SYSTEM: (System query language) Honeywell AZ-7 CODE to interface with the BEST system.

PROGRAM CODE

```
TITLES     ON   PAGING      ON  HEADING    ON  DATE   ON
TITLES    CUST-PRI = "PRI //CODE"
PICTURE   CUST-PRI = "XXX"
TITLES    CUST-CODE = "CUST//CODE"
PICTURE   CUST-CODE = "XXXX"
TITLES    FACILITY = "FACILITY  // NUMBER"
PICTURE   FACILITY = "XXXXXXXXXX"
TITLES    PW-NO = "PW           // NUMBER"
PICTURE   PW-NO = "XXXXXXXX"
TITLES    JOB-ORDER-NO = "JOB //NUMBER"
PICTURE   JOB-ORDER-NO = "XXXXXX"
TITLES    JOB-DESC = "JOB      // DESCRIPTION"
TITLES    REQUEST-DATE = "DATE        //REQUEST"
PICTURE   REQUEST-DATE = "SZZZZZ9"
TITLES    SHOP-COMP-DATE = "SHOP      // COMPL"
PICTURE   SHOP-COMP-DATE = "SZZZZZ9"
TITLES    TOT-EST-COST = "TOT.EST    //COST"
PICTURE   TOT-EST-COST = "SZZZZZZZ9"
TITLES    TOT-ACT-COST = "TOT.ACT    //COST"
PICTURE   TOT-ACT-COST = "SZZZZZZZ9"
TITLES    TOT-EST-LAB-HRS = "TOT.EST    //LABOR HRS"
PICTURE   TOT-EST-LAB-HRS = "SZZZZ9"
TITLES    TOT-ACT-LAB-HRS = "TOT.ACT    //LABOR HRS"
PICTURE   TOT-ACT-LAB-HRS = "SZZZZ9"
TITLES    XM= 'MONTH'
PICTURE   XM = 'SZZ9'
PICTURE   XM2 = 'SZZ9'
TITLES    XYTEMP = 'TEMP'
PICTURE   XYTEMP = '9999'
PICTURE   XYTEMP2 = '9999'
PICTURE   XY = 'SZZZZZ9'
PICTURE   XY2 = 'SZZZZZ9'
TITLE     XDAYS1 = 'DAYS'
PICTURE   XDAYS1 = 'SZZZZZ9'
PICTURE   XDAYS2 = 'SZZZZZ9'
TITLES    XDURATION = 'TOTAL DAYS     // IN SYSTEM'
PICTURE   XDURATION = 'ZZZ9'
LMARGIN    001  RMARGIN   132   HSPACE   001
VSPACE     001  ACROSS    001
```

```
PAGE      001
PAGE-LINES 055  FORM-LINES 066
HEADING "VARIANCE REPORT ON LENGTH OF TIME A WORK REQUEST
"// HAS BEEN IN THE SYSTEM BEFORE IT WAS COMPLETED"
"// THIS WILL SHOW ALL WORK REQUESTS BEFORE THE DATE OF"
"//DECEMBER 05 1988."
OPEN HW-HEAD
  IF   STATUS CONTAINS 'CHIT'
   OR STATUS CONTAINS 'PHONE'
   OR OPEN-1 GE '0000000000000001'
   OR CANCEL-DATE GE  1
   GO TO NR.
  IF    STOP-COMP-DATE LE "881205"
SORT BY ASCENDING CUST-PRI
                  FACILITY
COMPUTE  XM = 30.57 * RECD-MM
COMPUTE  XYTEMP = 1900 + RECD-YR
COMPUTE  XY = (365.25 * XYTEMP - 395.25)
COMPUTE  XDAYS1 = XM + XY + RECD-DY
COMPUTE  XM2 = 30.57 * COMP-MM
COMPUTE  XYTEMP2 = 1900 + COMP-YR
COMPUTE  XY2 = (365.25 * XYTEMP2 - 395.25)
COMPUTE  XDAYS2 = XM2 + XY2 + COMP-DY
COMPUTE XDURATION = XDAYS2 - XDAYS1
GO TO 02 ELSE GO TO NR.
VSPACE   1  TITLES ON
02
PRINT    CUST-PRI
         03
         CUST-CODE
         001
         FACILITY
         001
         PW-NO
            WITH TALLY
              (BY CUST-PRI)
         001
         JOB-ORDER-NO
         001
         JOB-DESC
         001
         REQUEST-DATE
         001
         SHOP-COMP-DATE
         001
         XDURATION
            WITH AVERAGE
              (BY CUST-PRI)
TALLY    PW-NO
TOTAL    TOT-EST-COST
TOTAL    TOT-ACT-COST
TOTAL    TOT-EST-LAB-HRS
```

```
TOTAL    TOT-ACT-LAB-HRS
AVERAGE  XDURATION
PAGING OFF
HEADING OFF
     IF LASTTIME
     SET ANAME 'LENGTH OF TIME'
     TITLES OFF
     PRINT '  '
          PRINT '  '
     PRINT '  '
     PRINT 'THE NAME OF THIS REPORT IS 'ANAME'
```

APPENDIX B

VARIANCE REPORT ON ESTIMATED VERSUS ACTUAL LABOR COSTS*

SYSTEM: (System query language) Honeywell AZ-7 code to interface with the BEST system.

PROGRAM CODE

```
TITLES    XM = 'MONTH'
PICTURE   XM = 'SZZ9'
PICTURE   XM2 = 'SZZ9'
TITLES    XYTEMP = 'TEMP'
PICTURE   XYTEMP = '9999'
PICTURE   XYTEMP2 = '9999'
PICTURE   XY = 'SZZZZZ9'
PICTURE   XY2 = 'SZZZZZ9'
TITLES    XDAYS1 ='DAYS'
PICTURE   XDAYS1 = 'SZZZZZ9'
PICTURE   XDAYS2 = 'SZZZZZ9'
TITLES    XDURATION = 'TOTAL DAYS     //IN SYSTEM'
PICTURE   XDURATION = 'ZZZ9'
TITLES    LC-CODE = 'LC'
PICTURE   LC-CODE = '99'
TITLES    CUST-PRI  = 'CUST//PRI'
PICTURE   CUST-PRI = 'XXX'
TITLES    JOB-ORDER-NO = 'JOB//NUMBER'
PICTURE   JOB-ORDER-NO = 'XXXXXXX'
TITLES    XLAB = 'LABOR/COST'
PICTURE   XLAB= 'SZZZZZ9.99'
LMARGIN     001   RMARGIN    132    HSPACE    001
VSPACE      001   ACROSS     001
PAGE        001
PAGE-LINES 055    FORM-LINES 066
HEADING   "TOTAL COST FOR LABOR"
          "//AND THE VARIANCES"
          "//OF LABOR SORTED BY BUILDINGS"
OPEN HW-HEAD
    IF STATUS EQ "CHIT"
          OR STATUS EQ 'CHITS'
          OR TOT-EST-COST-LAB EQ 0
          OR TOT-EST-COST-LAB EQ '   '
          OR CANCEL-DATE GE 1
          OR LC-CODE NE  07
          AND LC-CODE NE 06
          GO TO NR.
    SORT  BY ASCENDING LC-CODE MR-ALT-IMP  CUST-PRI
COMPUTE   XM = 30.57 * RECD-MM
COMPUTE   XYTEMP = 1900 + RECD-YR
```

```
COMPUTE  XY  = (365.25 * XYTEMP - 395.25)
COMPUTE  XDAYS1 = XM + XY + RECD-DY
COMPUTE  XM2 = 30.57 * COMP-MM
COMPUTE  XYTEMP2 = 1900 + COMP-YR
COMPUTE  XY2 = (365.25 * XYTEMP2 - 395.25)
COMPUTE  XDAYS2 = XM2 + XY2 + COMP-DY
COMPUTE  XDURATION  =  XDAYS2 - XDAYS1
  COMPUTE XLAB = TOT-ACT-COST-LAB - TOT-EST--COST-LAB
    PRINT PW-NO
          FACILITY
          JOB-ORDER-NO
          JOB-DESC-26
          CUST-PRI
          LC-CODE
          STATUS
          MR-ALT-IMP
          TOT-EST-COST-LAB
              WITH AVERAGE
                   (BY MR-ALT-IMP)
          TOT-ACT-COST-LAB
              WITH AVERAGE
                   (BY MR-ALT-IMP)
          XLAB
              WITH AVERAGE
                   (BY MR-ALT-IMP)
          XDURATION
              WITH AVERAGE
                   (BY MR-ALT-IMP)
AVERAGE XDURATION

PAGING OFF
HEADING OFF
IF LASTTIME
    SET ANAME = 'LABOR COST VARIANCE'
TITLES OFF
PRINT '  '
PRINT '  '
PRINT ' THE NAME OF THIS REPORT IS ' ANAME.
```

APPENDIX C

VARIANCE REPORT ON ESTIMATED VERSUS ACTUAL LABOR HOURS

SYSTEM: (System query language) Honeywell AZ-7 code to interface with the BEST system.

PROGRAM CODE

```
TITLES    XM = 'MONTH'
PICTURE   XM = 'SZZ9'
PICTURE   XM2 = 'SZZ9'
TITLES    XYTEMP = 'TEMP'
PICTURE   XYTEMP = '9999'
PICTURE   XYTEMP2 = '9999'
PICTURE   XY = 'SZZZZZ9'
PICTURE   XY2 = 'SZZZZZ9'
TITLES    XDAYS1 ='DAYS'
PICTURE   XDAYS1 = 'SZZZZZ9'
PICTURE   XDAYS2 = 'SZZZZZ9'
TITLES    XDURATION = 'TOTAL DAYS     //IN SYSTEM'
PICTURE   XDURATION = 'ZZZ9'
TITLES    LC-CODE = 'LC'
PICTURE   LC-CODE = '99'
TITLES    CUST-PRI  = 'CUST//PRI'
PICTURE   CUST-PRI = 'XXX'
TITLES    JOB-ORDER-NO = 'JOB//NUMBER'
PICTURE   JOB-ORDER-NO = 'XXXXXXX'
TITLES    XHRS = 'LABOR/HOURS'
PICTURE   XHRS = 'SZZZZZ9.99'
LMARGIN     001   RMARGIN    132    HSPACE    001
VSPACE      001   ACROSS     001
PAGE        001
PAGE-LINES 055   FORM-LINES 066
HEADING   "TOTAL LABOR HOURS"
         "//AND THE VARIANCE"
         "// OF LABOR HOURS SORTED BY MAINTENANCE AND REPAIR"
OPEN HW --HEAD
IF STATUS EQ "CHIT"
          OR STATUS EQ 'CHITS'
          OR TOT-EST-LAB-HRS EQ 0
          OR TOT-EST-LAB-HRS EQ '  '
          OR CANCEL-DATE GE 1
          OR LC-CODE NE  07
          AND LC-CODE NE 06
          GO TO NR.
     SORT BY ASCENDING LC-CODE MR-ALT-IMP  CUST-PRI
COMPUTE   XM = 30.57 * RECD-MM
COMPUTE   XYTEMP = 1900 + RECD-YR
```

```
COMPUTE  XY  = (365.25 * XYTEMP - 395.25)
COMPUTE  XDAYS1 = XM + XY + RECD-DY
COMPUTE  XM2 = 30.57 * COMP-MM
COMPUTE  XYTEMP2 = 1900 + COMP-YR
COMPUTE  XY2 = (365.25 * XYTEMP2 - 395.25)
COMPUTE  XDAYS2 = XM2 + XY2 + COMP-DY
COMPUTE  XDURATION  =  XDAYS2 - XDAYS1
COMPUTE  XHRS = TOT-ACT-LAB-HRS - TOT-EST-LAB-HRS
    PRINT PW-NO
          FACILITY
          JOB-ORDER-NO
          JOB-DESC-26
          CUST-PRI
          LC-CODE
          STATUS
          MR-ALT-IMP
          TOT-EST-LAB-HRS
              WITH AVERAGE
                   (BY MR-ALT-IMP)
          TOT-ACT-LAB-HRS
              WITH AVERAGE
                   (BY MR-ALT-IMP)
          XHRS
              WITH AVERAGE
                   (BY MR-ALT-IMP)
          XDURATION
              WITH AVERAGE
                   (BY MR-ALT-IMP)
AVERAGE XDURATION
PAGING OFF
HEADING OFF
IF LASTTIME
    SET ANAME = 'LABOR HOUR VARIANCE'
TITLES OFF
PRINT '  '
PRINT '  '
PRINT ' THE NAME OF THIS REPORT IS ' ANAME.
```

APPENDIX D

VARIANCE REPORT ON ESTIMATED MATERIAL COSTS VERSUS ACTUAL MATERIAL COSTS

SYSTEM: (System query language) Honeywell AZ-7 code to interface with the BEST system.

PROGRAM CODE

```
PICTURE  XMATERIAL  = 'SZZZZ9.99'
TITLES   XM = 'MONTH'
PICTURE  XM = 'SZZ9'
PICTURE  XM2 ='SZZ9'
TITLES   XYTEMP = 'TEMP'
PICTURE  XYTEMP = '9999'
PICTURE  XYTEMP2 = '9999'
PICTURE  XY = 'SZZZZZ9'
PICTURE  XY2 = 'SZZZZZ9'
TITLES   XDAYS1 = 'DAYS'
PICTURE  XDAYS1 = 'SZZZZZ9'
PICTURE  XDAYS2 = 'SZZZZZ9'
TITLES   XDURATION = 'TOTAL DAYS    //IN SYSTEM'
PICTURE  XDURATION = 'ZZZ9'
TITLES   LC-CODE = 'LC'
PICTURE  LC-CODE = '99'
TITLES   CUST-PRI = 'CUST/PRI'
PICTURE  CUST-PRI = 'XXX'
TITLES   JOB-ORDER-NO = 'JOB//NUMBER'
PICTURE  JOB-ORDER-NO = 'XXXXXXX'
LMARGIN    001   RMARGIN    132    HSPACE    001
VSPACE     001   ACROSS     001
PAGE       001
PAGE-LINES 055   FORM-LINES 066
HEADING  "TOTAL COST FOR MATERIAL"
        "//AND THE VARIANCES"
        "//OF MATERIALS SORTED BY BUILDINGS"
OPEN HW-HEAD
  IF STATUS EQ "CHIT"
         OR STATUS EQ 'CHITS'
         OR TOT-EST-COST-MAT EQ 0
         OR TOT-EST-COST-MAT EQ '   '
         OR CANCEL-DATE GE 1
         OR LC-CODE NE  07
         AND LC-CODE NE 06
         GO TO NR.
    SORT BY ASCENDING LC-CODE MR-ALT-IMP  CUST-PRI
COMPUTE  XM = 30.57 * RECD-MM
COMPUTE  XYTEMP = 1900 + RECD-YR
```

```
COMPUTE  XY = (365.25 *XYTEMP - 395.25)
COMPUTE  XDAYS1 = XM + XY + RECD-DY
COMPUTE  XM2 = 30.57 * COMP-MM
COMPUTE  XYTEMP2 = 1900 + COMP-YR
COMPUTE  XY2 = (365.25 * XYTEMP2 - 395.25)
COMPUTE  XDAYS2 = XM2 + XY2 + COMP-DY
COMPUTE XDURATION = XDAYS2 - XDAYS1
COMPUTE XMATERIAL = TOT-EST-COST-MAT - TOT-ACT-COST-MAT
    PRINT PW-NO
          FACILITY
          JOB-ORDER-NO
          JOB-DESC-26
          CUST-PRI
          LC-CODE
          STATUS
          MR-ALT-IMP
          TOT-EST-COST-MAT
              WITH AVERAGE
                   (BY MR-ALT-IMP)
          TOT-ACT-COST-MAT
              WITH AVERAGE
                   (BY MR-ALT-IMP)
          XMATERIAL
              WITH AVERAGE
                   (BY MR-ALT-IMP)
          XDURATION
              WITH AVERAGE
                   (BY MR-ALT-IMP)
AVERAGE XDURATION
PAGING OFF
HEADING OFF
IF LASTTIME
    SET ANAME = 'MATERIAL VARIANCE'
TITLES OFF
PRINT '  '
PRINT '  '
PRINT ' THE NAME OF THIS REPORT IS ' ANAME.
```

APPENDIX E

VARIANCE REPORT ON ESTIMATED TOTAL PROJECT COSTS VERSUS ACTUAL PROJECT COSTS

SYSTEM: (system query language) Honeywell AZ-7 code to interface with the BEST system.

PROGRAM CODE

```
TITLES    XM = 'MONTH'
PICTURE   XM = 'SZZ9'
PICTURE   XM2 = 'SZZ9'
TITLES    XYTEMP = 'TEMP'
PICTURE   XYTEMP = '9999'
PICTURE   XYTEMP2 = '9999'
PICTURE   XY = 'SZZZZZ9'
PICTURE   XY2 = 'SZZZZZ9'
TITLES    XDAYS1 ='DAYS'
PICTURE   XDAYS1 = 'SZZZZZ9'
PICTURE   XDAYS2 = 'SZZZZZ9'
TITLES    XDURATION = 'TOTAL DAYS     //IN SYSTEM'
PICTURE   XDURATION = 'ZZZ9'
TITLES    LC-CODE = 'LC'
PICTURE   LC-CODE = '99'
TITLES    CUST-PRI  = 'CUST//PRI'
PICTURE   CUST-PRI = 'XXX'
TITLES    JOB-ORDER-NO = 'JOB//NUMBER'
PICTURE   JOB-ORDER-NO = 'XXXXXXX'
TITLES    XCOST = 'LABOR/COSTS'
PICTURE   XCOST = 'SZZZZZ9.99'
LMARGIN     001   RMARGIN    132    HSPACE    001
VSPACE      001   ACROSS     001
PAGE        001
PAGE-LINES 055    FORM-LINES 066
HEADING   "TOTAL COSTS"
         "//AND THE VARIANCE"
         "// OF TOTAL COSTS SORTED BY MAINTENANCE AND REPAIR"
OPEN HW-HEAD
IF STATUS EQ "CHIT"
          OR STATUS EQ 'CHITS'
          OR TOT-EST-COST EQ 0
          OR TOT-EST-COST EQ '   '
          OR CANCEL-DATE GE 1
          OR LC-CODE NE  07
          AND LC-CODE NE 06
          GO TO NR.
     SORT BY ASCENDING LC-CODE MR-ALT-IMP  CUST-PRI
COMPUTE   XM = 30.57 * RECD-MM
```

```
COMPUTE  XYTEMP = 1900 + RECD-YR
COMPUTE  XY  = (365.25 * XYTEMP - 395.25)
COMPUTE  XDAYS1 = XM + XY + RECD-DY
COMPUTE  XM2 = 30.57 * COMP-MM
COMPUTE  XYTEMP2 = 1900 + COMP-YR
COMPUTE  XY2 = (365.25 * XYTEMP2 - 395.25)
COMPUTE  XDAYS2 = XM2 + XY2 + COMP-DY
COMPUTE  XDURATION  =  XDAYS2 - XDAYS1
COMPUTE  XCOST = TOT-ACT-COST - TOT-EST-COST
    PRINT PW-NO
          FACILITY
          JOB-ORDER-NO
          JOB-DESC-26
          CUST-PRI
          LC-CODE
          STATUS
          MR-ALT-IMP
          TOT-EST-COST
              WITH AVERAGE
                   (BY MR-ALT-IMP)
          TOT-ACT-COST
              WITH AVERAGE
                   (BY MR-ALT-IMP)
          XCOST
              WITH AVERAGE
                   (BY MR-ALT-IMP)
          XDURATION
              WITH AVERAGE
                   (BY MR-ALT-IMP)
AVERAGE XDURATION
PAGING OFF
HEADING OFF
IF LASTTIME
    SET ANAME = 'TOTAL COST VARIANCE'
TITLES OFF
PRINT '  '
PRINT '  '
PRINT ' THE NAME OF THIS REPORT IS ' ANAME.
```

APPENDIX F

BACKLOG OF WORK REQUESTS BROKEN DOWN BY WORK CENTERS AND TRADES AWAITING MATERIAL

SYSTEM: (System query language) Honeywell AZ-7 code to interface with the BEST system.

PROGRAM CODE

```
TITLES    ON    PAGING     ON  HEADING     ON  DATE        ON
TITLES     WCC-NO ="WCC      //NUMBER"
PICTURE    WCC-NO = "XXXXX"
TITLES     WICDETL-PW-NO = "  PW       //NUMBER"
PICTURE    WICDELT-PW-NO = "XXXXXXXX"
TITLES     FACILITY = "FACILITY  //NUMBER"
PICTURE    FACILITY = "XXXXXXXXXX"
TITLES     JOB-ORDER-NO  = "JOB-ORDER  // NUMBER"
PICTURE    JOB-ORDER-NO = "XXXXXXXXXXXXX"
TITLES     JOB-DESC-26  = "JOB DESC  //26 CHARS"
TITLES     OPEN-2 = "DELAY      //CODE"
PICTURE    OPEN-2  = "X"
TITLES     EST-COST-MAT = "MATERIAL  //COST"
PICTURE    EST-COST-MAT = "SZZZZZZ9"
TITLES     EST-COST-LAB = "LABOR     //COST"
PICTURE    EST-COST-LAB = "SZZZZ9"
TITLES     EST-LAB-HRS  = "EST HOURS  // LABOR"
PICTURE    EST-LAB-HRS  = "SZZZZ9"
TITLES     REQUIR-COMP-DATE = "DATE COMP  // REQUIRED"
PICTURE    REQUIR-COMP-DATE = "SZZZZZ9"
TITLES     WCC-NO = "WCC       //NUMBER"
PICTURE    WCC-NO = "XXXXX"
TITLES     WICDETL-PW-NO = "   PW     //NUMBER"
PICTURE    WICDETL-PW-NO = "XXXXXXXXXXXXX"
TITLES     FACILITY = "FACILITY  // NUMBER"
PICTURE    FACILITY = "XXXXXXXXXXXXX"
TITLES     JOB-ORDER-NO = "JOB ORDER // NUMBER"
PICTURE    JOB-ORDER-NO = "XXXXXXXXXXXXX"
TITLES     JOB-DESC-26 = "JOB DESC   //26 CHARS"
TITLES     OPEN-2 = "2ND OPEN   //FIELD"
PICTURE    OPEN-2 = "XXXXXXX"
TITLES     REQUIR-COMP-DATE  =  "DATE COMP // REQUIRED"
PICTURE    REQUIR-COMP-DATE  =  "SZZZZZ9"
LMARGIN     001    RMARGIN     132     HSPACE     001
VSPACE      001    ACROSS      001
PAGE        001
PAGE-LINES 055    FORM-LINES 066
HEADING     "BACKLOG OF WORK REQUESTS"
"//BROKEN DOWN BY WORK CENTERS // WITH A DELAY CODE OF
```

```
MATERIAL"
"//FOR ALL WORK IN THE SYSTEM."
OPEN  WICDETL
      WICHEAD
FIND WICHEAD-PW-NO
    = WICDETL-PW-NO
IF    OPEN-2 EQ "M"
    AND CUST-PRI NE "SJO"
    AND JOB-ORDER-NO GE "9000AA"
    AND JOB-ORDER-NO LE "8FF999"
    OR JOB-ORDER-NO GE "8RB000"
   GO TO 01 ELSE GO TO NR.
01
    SORT BY ASCENDING  WCC-NO
    FIND WICHEAD-PW-NO
       = WICDETL-PW-NO
    TALLY      WCC-NO
         BY WCC-NO
    TOTAL      EST-COST-MAT
         BY WCC-NO
    TOTAL      EST-COST-LAB
         BY WCC-NO
    TOTAL      EST-LAB-HRS
         BY WCC-NO
    TALLY      WCC-NO
    TOTAL      EST-COST-MAT
    TOTAL      EST-COST-LAB
    TOTAL      EST-LAB-HRS
    VSPACE     1    TITLES ON
    PRINT      WICDETL-PW-NO
               001
               FACILITY
               001
               JOB-ORDER-NO
               001
               JOB-DESC-26
               001
               OPEN-2
               001
               WCC-NO
               001
               EST-COST-MAT
               001
               EST-COST-LAB
               001
               EST-LAB-HRS
               001
               REQUIR-COMP-DATE
SORT BY CUST-CODE
PAGING OFF
HEADING OFF
    IF LASTTIME
```

```
 SET ANAME = "BACKLOG MATERIAL"
TITLES OFF
PRINT '   '
PRINT '   '
PRINT ' THE NAME OF THIS REPORT IS 'ANAME.
```

APPENDIX G

BACKLOG OF WORK REQUESTS BROKEN DOWN BY WORK CENTERS AND TRADE AWAITING LABOR

SYSTEM: (System query language) Honeywell AZ-7 code to interface with the BEST system.

PROGRAM CODE

```
TITLES    ON   PAGING    ON  HEADING    ON  DATE        ON
TITLES     WCC-NO ="WCC      //NUMBER"
PICTURE    WCC-NO = "XXXXX"
TITLES     WICDETL-PWPNO = "  PW      //NUMBER
PICTURE    WICDELT-PW-NO = "XXXXXXXXXXXXX"
TITLES     FACILITY = "FACILITY  //NUMBER"
PICTURE    FACILITY = "XXXXXXXXXX"
TITLES     JOB-ORDER-NO  = "JOB-ORDER  // NUMBER"
PICTURE    JOB-ORDER-NO = "XXXXXXXXXXXXX"
TITLES     JOB-DESC-26  = "JOB DESC  //26 CHARS"
TITLES    OPEN-2 = "2ND OPEN  //FIELD"
PICTURE   OPEN-2 = "XXXXXXX"
TITLES    EST-COST-MAT  = "   MATERIAL  // COST"
PICTURE   EST-COST-MAT = "SZZZZZZ9"
TITLES    EST-COST-LAB = "  LABOR  // COST"
PICTURE   EST-COST-LAB = "SZZZZ9"
TITLES    EST-LAB-HRS = "ESTIMATED  //LABOR HRS"
PICTURES EST-LAB-HRS = "SZZZZ9"
TITLES    REQUIR-COMP-DATE = "DATE COMP  //REQUIRED"
PICTURE    REQUIR-COMP-DATE = "SZZZZZ9"
LMARGIN     001   RMARGIN    132    HSPACE    001
VSPACE      001   ACROSS     001
PAGE        001
PAGE-LINES 055   FORM-LINES 066
HEADING    "BACKLOG OF WORK REQUESTS"
"//BROKEN DOWN BY WORK CENTERS // WITH A DELAY CODE OF
LABOR"
"//FOR ALL WORK IN THE SYSTEM."
OPEN  WICDETL
      WICHEAD
FIND WICHEAD-PW-NO
    = WICDETL-PW-NO
IF    OPEN-2 EQ "L"
    AND CUST-PRI NE "SJO"
    AND JOB-ORDER-NO GE "9000AA"
    AND JOB-ORDER-NO LE "8FF999"
    OR JOB-ORDER-NO GE "8RB000"
   GO TO 01 ELSE GO TO NR.
01
```

```
     SORT BY ASCENDING  WCC-NO
     FIND WICHEAD-PW-NO
        = WICDETL-PW-NO
     TALLY      WCC-NO
          BY WCC-NO
     TOTAL      EST-COST-MAT
          BY WCC-NO
     TOTAL      EST-COST-LAB
          BY WCC-NO
     TOTAL      EST-LAB-HRS
          BY WCC-NO
     TALLY      WCC-NO
     TOTAL      EST-COST-MAT
     TOTAL      EST-COST-LAB
     TOTAL      EST-LAB-HRS
     VSPACE     1    TITLES ON
     PRINT      WICDETL-PW-NO
                001
                FACILITY
                001
                JOB-ORDER-NO
                001
                JOB-DESC-26
                001
                OPEN-2
                001
                WCC-NO
                001
                EST-COST-MAT
                001
                EST-COST-LAB
                001
                EST-LAB-HRS
                001
                REQUIR-COMP-DATE
SORT BY CUST-CODE
PAGING OFF
HEADING OFF
     IF LASTTIME
      SET ANAME = "BACKLOG LABOR"
     TITLES OFF
     PRINT '   '
     PRINT '   '
     PRINT ' THE NAME OF THIS REPORT IS 'ANAME.
```

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